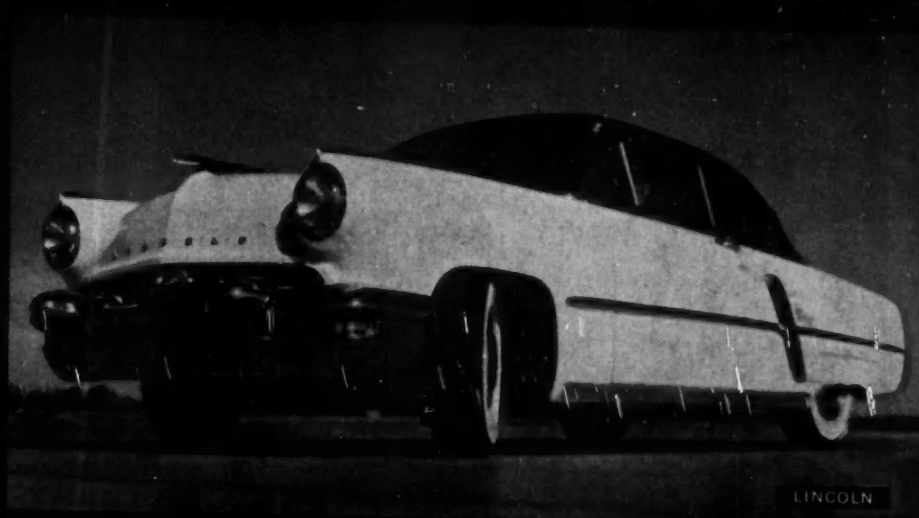
Product Engineering

FEBRUARY 1953

BUICK

Design Features of 1953 Cars



LINCOLN

PACKARD

A McGRAW-HILL PUBLICATION

FIVE DOLLARS A YEAR

Half-soles for a Behemoth . .

SHARON* HI-STRENGTH STEELS DELIVER MAXIMUM STRENGTH FOR TANK TRACKS

Tank parts must absorb a lot of punishment. Rough terrain, twisting directional turns, cannon recoil, quick starts and stops are a few of the reasons why modern tanks must take it.

To overcome failure through metal fatigue designers today are specifying that most parts of this vital mechanism be constructed of hi-strength steels. As a leader in the production of such special alloys Sharon has had a large part in the production of hi-strength steels for military purposes.

These same Sharon hi-strength steels are becoming increasingly available for product improvement for civilian consumption. If you're in the market for tough steels that will do more, talk to the Sharon man in your area.

*Specialists in STAINLESS, ALLOY, COLD ROLLED and COATED Strip Steels.

SHARON STEEL CORPORATION

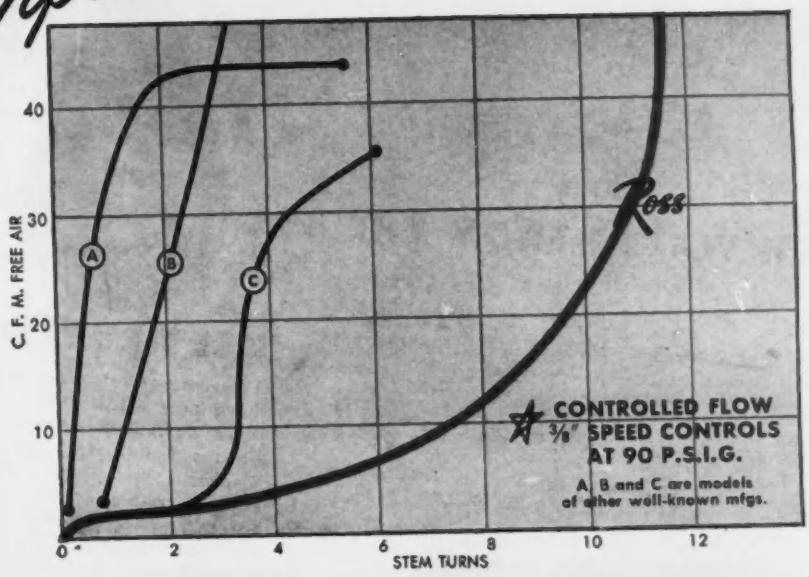
Sharon, Pennsylvania

DISTRICT SALES OFFICES: CHICAGO, ILL., CINCINNATI, O., CLEVELAND, O., DAYTON, O., DETROIT, MICH., INDIANAPOLIS, IND., MILWAUKEE, WIS., NEW YORK, N. Y., PHILADELPHIA, PENNA., ROCHESTER, N. Y., LOS ANGELES, CALIF., SAN FRANCISCO, CALIF., MONTREAL, QUE., TORONTO, ONT.

For information on Titanium contact Mallory-Sharon Titanium Corp., Niles, Ohio

SHARONSTEEL

Compare ☆



☆ Free flow capacity of the Ross Speed Control Valve is 25% TO 125% GREATER.

ROSS

Speed Control Valve

☆ Easy-to-read graph of flow

☆ Maximum free flow

☆ Simple, dependable, rugged

☆ Small, lightweight

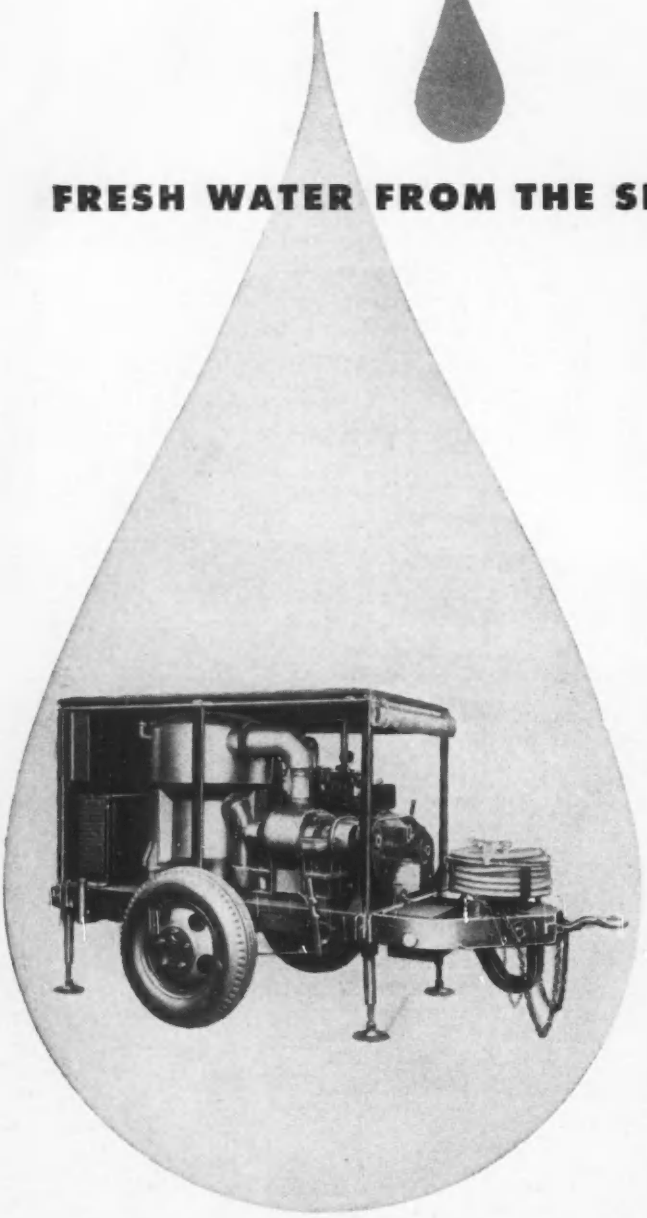
Write for complete details.

ROSS Control

ROSS OPERATING VALVE COMPANY

120 E. GOLDEN GATE AVE., DETROIT 3, MICHIGAN

FRESH WATER FROM THE SEA ...?



Portable Diesel-driven sea-water compression still, producing 85 gallons of pure water per hour. Made by Cleaver-Brooks Company, Special Products Division, Waukesha, Wis., which also makes stationary installations for chemical, paper, pharmaceutical and similar plants, for production of pure water or recovery of valuable by-products.

USE REVERE METALS!

This is a portable compression still, which produces pure distilled water from the sea at the rate of 85 gallons per hour. It is made by Cleaver-Brooks Company, Special Products Division, Waukesha, Wis., an important producer of stills, either portable or stationary, for the Armed Forces and for industry. An important feature of Cleaver-Brooks design is the selection of metals in accordance with the water conditions to be met, whether salt, brackish, contaminated, or requiring recovery of valuable by-products. Thus, for example, the heat exchanger, of the tube-within-a-tube type may have cupro-nickel tubes and headers, or Admiralty tubes, naval brass, silicon bronze, according to the nature of the service. Such care in selection of metals is in part at least responsible for the high reputation Cleaver-Brooks enjoys.

In addition to supplying Revere Metals, we were also requested to collaborate with engineers and production men on fabrication methods, including forming, brazing, welding and annealing. Cleaver-Brooks is a large and well-staffed company, and its experience is such that it is capable of conducting its operations unassisted. However, like so many companies, it likes to have others double-check its conclusions and methods, to protect itself and its customers. The Revere Technical Advisory Staff was glad to respond to the call.

Such work is typical of the collaboration Revere offers to you through its salesmen, its Technical Advisors, and the Research Department. Remember, we do not take the place of your own engineers, designers and production people; we consult with them, and make our knowledge freely available, on a confidential basis, of course. Call the nearest Revere Sales Office. Consult your telephone book or write direct.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

VOLUME 24 **Product Engineering** NUMBER 2

G. F. NORDENHOLT, *Editor*

Assistant to the Editor, Joseph Kerr • *Managing Editor*, V. H. Laughner
Associate Editors, E. S. Cobb, R. P. Dominic • *Assistant Editors*, N. J. Van Ness, L. H. Young, B. K. Ledgerwood, P. N. Anderson, R. E. Abbott • *Editorial Assistants*, R. W. Bruley, Lillian M. Witham
Consulting Editor, Robert E. Bruckner • *Washington*, George B. Bryant, Jr.
Assistant Publisher, W. E. Kennedy • *Advertising Sales Mgr.*, Stanley J. Alling • *Service Mgr.*, Hugh Britton
Publisher, Albert Hauptli

Foreign News Bureau: London • Paris • Berlin • Moscow • Tokyo • Melbourne • Rio de Janeiro • Buenos Aires • Manila

FEBRUARY 1953

Which Engine Should Power Your Equipment? by A. F. Milbrath 119
When air-cooled internal combustion engines can be used to power machines, and how to select them.

Wear Properties of Ductile Cast Iron 125
Test and service data indicate ductile iron's good wear resistance.

Fatigue Testing—Its Machines and Methods by T. R. Breunich 128
Problems of fatigue testing, with descriptions of single-purpose and universal testing machines.

Design Features of 1953 Cars 135
Engineering details of the following cars: Lincoln • Ford • Mercury • Packard • Kaiser • Chrysler • Plymouth • De Soto • Dodge • Willys • Cadillac • Chevrolet • Buick • Oldsmobile • Studebaker.

Designing an Ideal Sand Casting by T. H. Trevithick 168
Some suggestions for solving foundry problems before they arise.

Oil Whip by D. P. Timo 171
What it is and how to prevent it both by design and by using anti-whip bearings.

Modified Geneva Drives and Special Mechanisms by Sigmund Rappaport 174
Sketches and descriptions of specific mechanisms that were selected for their practical significance.

Putting the Squeeze on Cold Welding by Norman Grossman 176
Basic design data covering such items as materials, optimum thicknesses and deformations.

Tubes for Industrial Inspection and Control by Ralph B. Immel 182
Types of circuits, and the performance that can be expected when used with selected basic tubes.

Aluminum Honeycomb Sandwich Structures 184
Details of construction and use. Comparison with fabric core structures.

Flexure Pivots—Design Formulas and Charts by Arthur G. Thorp, II 192
Frictionless joints that permit small rotations in force measuring systems.

A Practical Method for Designing Gear Trains by M. F. Spotts 211
Developed for the engineer who wants an answer in the shortest possible time.

Nomogram for Evaluating Test Data by Edward C. Varnum 215
Facilitates comparing two sets of data to determine if difference is significant.

Highlights 5
Front Cover 9
Design Perspectives 113
Editorial 117
Technical News 201
New Parts and Materials 216
New Catalogs and Bulletins 230A
Meetings 258
Sans, Souci 260
Engineering Abstracts 266
Our Readers Say 283
New Books 292

February, 1953 **Product Engineering** **Vol. 24, No. 2**

Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication office, 99-129 North Broadway, Albany 1, N. Y.**

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B. Smith, Vice-President, Editorial Director; Nelson Bond, Vice-President, Director of Advertising; J. E. Blackburn, Jr., Vice-President, Circulation.

Subscriptions: Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

Branch Offices: ATLANTA, B. M. Maultsby, 1321 Rhodes-Haverty Bldg.; BOSTON, M. A. Williamson, Jr., 350 Park Square Bldg.; CHICAGO, Anson E. Meanor, H. M. Higgins, 520 N. Michigan Ave.; CLEVELAND, A. F. Tischer, 1510 Hanna Bldg.; DALLAS, J. H. Cash, First National Bank Bldg.; DETROIT, P. B. Robinson, 856 Penobscot Bldg.; LOS ANGELES, H. L. Keeler, 1111 Wilshire Blvd.; NEW YORK, P. G. Weatherby and D. C. McGraw, Jr., 330 W. 42nd St.; PHILADELPHIA, David G. Jones, Architects Bldg.; PITTSBURGH, A. F. Tischer, 738-9 Oliver Bldg.; SAN FRANCISCO, R. E. Dorland, Jr., 68 Post St.; WASHINGTON, National Press Bldg.; LONDON, McGraw-Hill House, 95 Farringdon St., London E.C. 4, England.

Single copies 50¢. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $13 for three years; Latin American countries, $15 for one year, $25 for two years, $36 for three years; all other countries $25 for one year, $40 for two years, $50 for three years. Entered as second class matter August 21, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1953 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved.

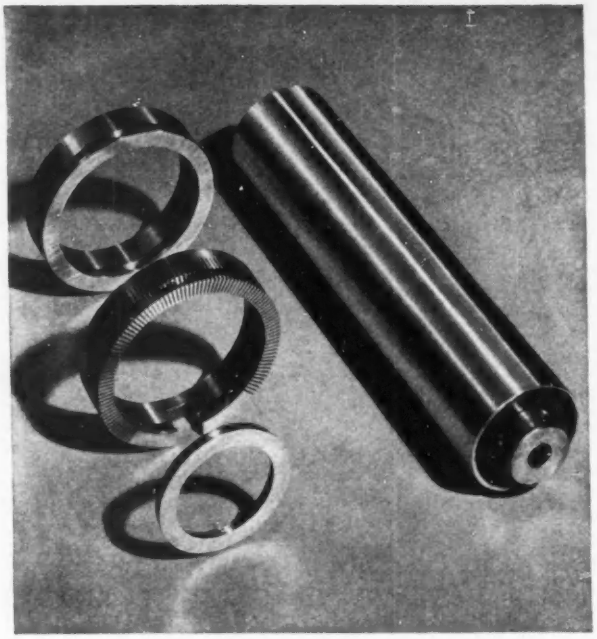
A McGRAW-HILL PUBLICATION

Member of Associated Business Publications and Audit Bureau of Circulations

Number of copies printed this issue 24,484

For a Heavy, Dense Plating of High Purity Silver

...Investigate the Mallosil® Process



WHAT IS THE MALLOSIL PROCESS?

It is a process for electroplating a hard, dense coating of practically pure (99.90%) silver on a base metal. It bonds silver securely to ferrous metals, copper and copper alloys, zinc and aluminum base alloys.

WHERE IS IT USED?

The photograph above is a good example. It is a Mallosil plated contactor ring used in the speed control of a Diesel electric locomotive. Other applications include: sliding contacts and switches; tank and container linings; for contact surface on electrical sorting devices and commutator rings. Mallosil is also used to apply contact surfaces to fuse clips, sockets and large contact arms which require low voltage drop or which must withstand repeated impact stresses. Sheet, wire and rod stock can be plated with a coating that will not separate during fabricating and forming operations.

WHAT ARE ITS CHARACTERISTICS?

The non-porous, oxygen-free silver has a bright, smooth surface. Corrosion resistant properties of the silver assure uninterrupted performance for electrical and electronic applications. Plating thickness can be as low as .0003" to as high as .060". Its thermal and electrical conductivity is 105% of copper. It withstands galling, seizing and "leading-up" when subjected to metal-to-metal contact. Other properties include: U.T.S. . . . 45-50,000 psi. Hardness . . . Rockwell "H" 110.

LIMITATIONS

Present equipment for Mallosil plating permits Mallory to plate parts up to 20" x 14" x 14" over-all size, weighing 35 pounds or less.

TO GET MORE INFORMATION

. . . write the Metals and Ceramics Division, P. R. Mallory & Co., Inc., Indianapolis 6, Indiana. If you have a problem, we'll be glad to work with you. In any event, let us send you a copy of our new Technical Bulletin 6-3. It contains complete information on the Mallosil process.

Expect more . . . Get more from MALLORY

Special Metals and Ceramics

P.R. MALLORY & CO. Inc.

MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear

NONMETALLIC MATERIALS

NEW PRIMER for vinyl finishes on rusty steel shows excellent results. Carboline Company, St. Louis, developed the primer to stop peeling of polyvinyl chloride finishes from rusty steel. The primers vehicle gives it high polarity, excellent edge coverage, and an ability to reduce rust to basic iron.

EXHAUST HOUSINGS of aircraft cooling systems are being made from glass reinforced alkyd. Electroflow Pumps, Inc, Los Angeles, Calif, reports that the housings must withstand temperature changes from +257F to -131F and high pressures built up by the motor blowers. The alkyd is reported withstanding this high thermal shock without mechanical damage.

A FASTER CYCLE RATE has increased the use of beryllium copper for injection molds. Standard Tool Co., Leominster, Mass, states that 40 to 50 percent of the companies molds have beryllium copper cavities, as against 10 percent a year ago. The faster cycle rate makes possible a 5 to 30 percent time saving.

LOOSE FITS OF 0.005 IN. can be brazed using a new copper brazing paste containing iron. Developed by the Glidden Co., Cleveland, Ohio, the paste gives satisfactory bridging and high strength joints. Loose tolerance permits hand assembly of parts rather than hydraulic or mechanical joining.

TWO TOUGHER aluminum alloys under development are highly resistant to corrosion. Aluminum Co. of America report the alloys XA54S and XC56S permit using section thickness half or less than those required by aluminum alloys commonly used for the same job. Both are weldable using inert gas. Welds are ductile and have high elongation.

INDIUM METAL is predicated for use in magnets, electronics and lubricants. The Electrochemical Society states that preliminary investigations of Indium in ferromagnetic Heusler alloy shows promise; Indium as a capacitor electrode appears to warrant investigation; and that it maintains lubricants in noncorrosive condition paint.

TEMPERATURES AS HIGH AS 200F can be withstood by a newly developed heat-resistant plastic. Designated, Styron 700, by the Dow Chemical Co, Midland, Mich, this is more than 20F higher than regular polystyrene can take, It is expected to be used for battery cases and covers, electrical coil forms, and bases for printed circuits.

METALLIC MATERIALS

MOLYBDENUM DISULPHIDE to stop fretting corrosion has a promising future. NACA tests indicate the fretting is caused by the loosening of finely divided material. Vibration, oxygen, lubrication hardness, load and surface roughness hasten this surface corrosion.

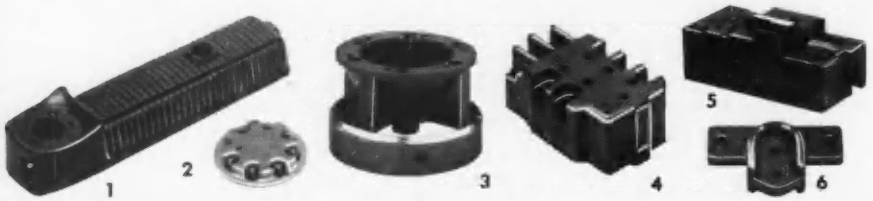
EXPLORATORY WORK to determine fabrication techniques and obtain engineering design data necessary for the use of titanium is being undertaken by Northrop Aircraft Inc. The F - 89D tip pod is to used because of its variety of forming, machining, welding and other airframe fabrication techniques.

PLATING ON ALUMINUM is materially improved by the addition of a small amount of iron. Aluminum Co. of America research engineers state that about one to two grams per liter of ferric chloride crystals added to the alkaline zincate immersion dip improves subsequent electroplating. The high percentage of copper silicon and magnesium found in the casting alloys makes the addition of iron especially valuable in the plating of aluminum die castings. The plated part has an excellent appearance.

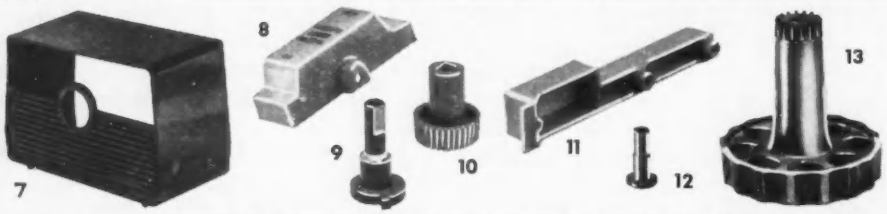
(continued on page 7)

What's YOUR Line?

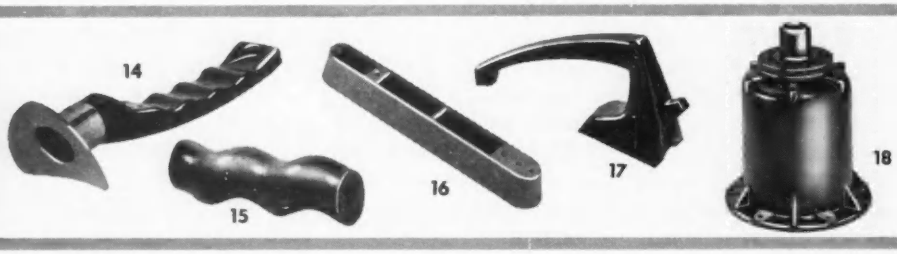
ELECTRIC ELECTRONIC ?



RADIO TELEVISION MUSIC ?



APPLIANCES HOUSEWARES ?



SOMETHING ELSE ?

These applications demonstrate *our* line—custom moulding of thermosetting plastics. Complete moulding facilities, including design and mould-making!

Note, please, that some of these parts are quite intricate. Note, too, that while the majority of these pieces are moulded of standard thermosetting materials, quite a few are made of newer materials with which we've acquired a working knowledge almost unique in the industry. Pieces numbered 19, 20, 23, and 24 are moulded of Teflon—those numbered 2, 21 and 22, of glass-reinforced plastics—numbers 6 and 12, of Alkyd.

Based on experience like this, don't you think *your* line could benefit from service by *our* line? Phone or write our Dayton office—or your local branch office—for full information.

Kurz-Kasch, Inc. • 1427 S. Broadway • Dayton 1, Ohio

BRANCH SALES OFFICES: New York, Lexington 2-6677 • Rochester, Hillside 4352 • Chicago, Merrimac 7-1830 • Detroit, Trinity 3-7050 • Philadelphia, Hilltop 6-6472 • Dallas, Logan 6-5234 • Los Angeles, Richmond 7-5381 • St. Louis, Delmar 9577 • Toronto, Riverdale 3511
EXPORT OFFICE: 89 Broad Street, New York City, Bowling Green 9-7751.

Kurz-Kasch

FOR OVER 36 YEARS PLANNERS AND MOULDERS IN PLASTICS

LIFE EXPECTENCY of moving parts in heavy equipments has been increased by chrome plating. A Chromium Corp of America, Chicago,

report states that parts subjected to gases, dust, and other contaminants last longer when plated. Chrome plating also increase packing life and downtime for scoring is reduced as field repairs can often be made. Minimum chromium plate thickness is 0.001 in. with an average of 0.010 inches. Plating thicknesses of 0.15 have been used.

CLEANING OF STAINLESS STEEL by using an ultrasonic transducer is being done by the Allegheny Ludlum Steel Co. Radio frequencies, just above the audible sound range, of 23,000 to 26,000 cycles are used to determine the descaling effect upon steel and its alloys.

PROCESSES

CLOSER TOLERANCES, better machinability, and superior finishes are reported through use of compression forming of tubes. Tube Reducing Corp, Wallington, NJ, states that in compression forming, the desired reduction is obtained by rocking special dies back and forth over a stationary die. The inside diameter is pressed against precision-sized polished mandrel. Tolerances can be held for long production runs.

CORROSION TREATMENT OF MILD STEEL and other ferrous metals is reported ready for industrial application. Tests conducted by Vega Aircraft Corp, California, indicates a substantial reduction in the loss of critical metallic materials by corrosion between manufacture and use. Known as Permyron, treated metal forms a dense undercoating or primer for baked and air-dryed paint; an inert flexible base resistance to weathering or acid; and maintains bonding power and corrosion protection after considerable deformation and weathering.

ABRASIVE BELT is used to sharpen tungsten carbide-tipped tools. The belt developed by Behr-

Manning Corp, Trop, N.Y. is used on a Fenlind "Micro Finisher" machine. The waterproof paper coated with silicone carbide abrasive is said to double the work-life of the tool. Two steps are claimed to be eliminated - the intermediate grind and the diamond honing of burrs left on the cutting edge.

SPRAY-ON-DYE PENETRANT inspection kit for locating cracks in any solid material has been developed by the Magnaflux Corporation, Chicago, Ill. Dye penetrant is sprayed on the clean surface of the part to be checked. Then a cleaner is used, removed by a quick wipe and a white developer brushed on. Cracks will show as bright red lines and pores and leaks in tanks as bright red spots. The portable kit can be used on large equipment that cannot be moved and on field equipment.

ELECTRIC CABLE that combines the advantages of an aluminum extrusion and the corrosion resistance of copper has been patented by the British Insulated Callender Cables Ltd. British Patent 679,218 describes the sheath which comprises an inner layer of aluminum bonded to an outer layer of copper. The bond is made by drawing the cable enclosed in an aluminum tube into an oversize copper tube. The assembly is drawn to elongate it and to cause the copper tube to fit tightly over the aluminum tube and compact the powder insulation. The assembly is then annealed and ready for use.

BONDING of natural, synthetic or silicone rubber to metal is possible by use of a special pro-

cess, developed by the Advance Rubber Co., Minneapolis, Minn. The Method allows parts with metal cores to be ground concentric to tolerances of ±0.002. Rubber and metal nuts and bushings can be tightened without breaking and metal can be used in rubber items where rigidity as well as resiliency is required.

COMPONENTS

PLATED ALUMINUM grid storage battery has full effectiveness at temperatures from -55F to +165F. Developed by the Army Ordnance Corp, the battery has a lowered self discharge rate than conventional units. This makes it useful for emergency stand-by power as well as for military and civilian vehicles.

HIGH SUCTION LIFT over a wide temperature and viscosity range is reported for a stainless steel pump. Eco Engineering Co, Newark, N.J., states that the pump has a maximum pressure of 70 psi and can safely handle corrosive and hazardous fluids. Chemically inert teflon self lubricated bearings, impellers, and stuffing boxes are used. Pump is self priming.

(continued on page 9)

FARVAL—*Studies in Centralized Lubrication* No. 139

Farval Announces DC 20 Automatic Pumping Unit

for complete lubrication of smaller machines

NOW any small machine can have a completely automatic system of Farval centralized lubrication—as efficient and economical as the larger systems which have proved so valuable on heavy industrial equipment during the past 26 years.

Chief component of this smaller, low cost system is the new Farval DC20 pumping unit which handles either grease or oil. In addition to the pumping unit, the complete Farval system consists of two main supply lines, the familiar Dualine measuring valves and discharge line connections from measuring valves to the bearings.

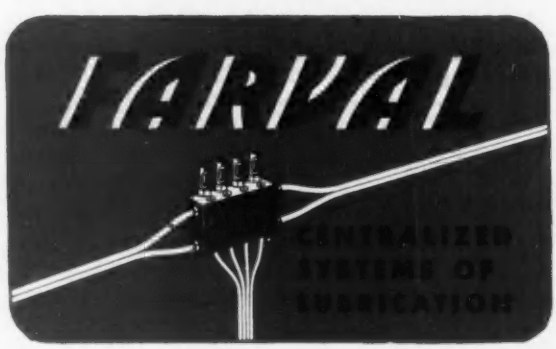
Easily installed at any convenient place on or near a machine, the DC20 insures automatic delivery of lubricant to bearings, as often as needed, in whatever quantities desired, while the machine is in operation. Remember that Farval—and Farval only—employs the Dualine valve that is fully adjustable—simple, sure and foolproof—with a positive indicator which visually signals that the valve has functioned.

Hundreds of operators using the larger Farval automatic systems have discovered that the entire cost of a system is saved the first year. Lubricant savings alone may run as high as 75%.

Investigate the new DC20. Near you is an experienced Farval lubrication engineer who will demonstrate how the new DC20 pumping unit can save time and money and increase production on your present hand-lubricated machines. Write today for a copy of Bulletin 39, "DC20 Pumping Unit for Smaller Machines". The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

ALL PARTS OF THIS NEW FARVAL DC20 *automatic pumping unit are assembled on a single base plate ready for quick, easy mounting at any convenient point. Supply lines run from the pumping station to the Dualine measuring valve manifolds, one valve for each bearing to be lubricated. The entire system is installed very simply and at a cost that will be repaid in a few months in savings effected.*



SPEED VARIATIONS of varidrive motors can be made by pneumatic remote control. A recent development of U. S. Electrical Motors Inc., Los Angles, Calif, the control permits motor positioning at air pressures of 60 or 100 psi through an air operated plunger attached to the motors changing device. The control can operate a group of motors being used at the same speed and can provide speed changes from one preset value to another by a single movement of the control.

HIGH VOLTAGE RECTIFIER TUBES for industrial use have been developed by Westinghouse, Elmira, N. Y. Type 6102 is for use involving peak inverse voltages up to 40KV and for oil immersed operation. Type 6103 is designed for peak inverse voltages up to 20KV and is provided with integral radiation for forced air cooling.

MINIATURE RELAYS in small hermetically sealed enclosures weighing 0.11 lb are available. According to the Automatic Electric Corp, Chicago, Ill., the relays are designed for minimum inductance and maximum make-and-break speeds. They are for use where shock, temperature or vibration is present.

TESTING

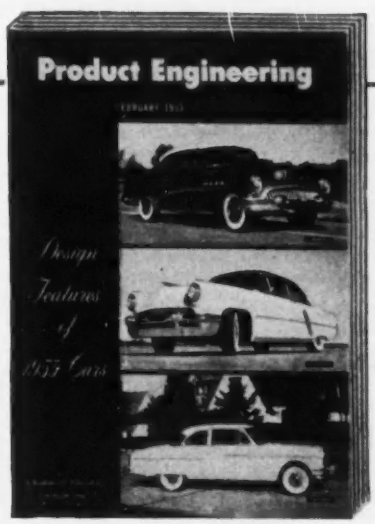
EXPERIMENTS ARE CURRENTLY being conducted to study the residual stresses of surfaces that are being ground. The Mellon Institute, Pittsburgh, Pennsylvania, states that future studies will include methods of alleviating grinding stresses to determine their effect upon service life.

LOUDSPEAKER CLUTCH developed for instrument test applications, works on the same principle as a radio loudspeaker. Force resulting from the interaction of a coil current and a magnetic field moves the coil and causes the clutch out-put disk to be pressed against the rotating input member. National Bureau of Standards states that the experimental models full output shaft torque of 10 oz-in. was attained in less than a third of a millisecond.

ELECTROSTATIC CHARGES can be detected and measured by use of a recently developed instrument. The designers are Baldwin Instrument Co., Ltd., Dartford, Kent, England. In operation, the pistol shaped instrument is aimed towards the object suspected of carrying an electrostatic charge. Voltage is read directly on the instrument dial. Scale is 0-2,000 v per foot. If needed, an adjustable sleeve on the instrument is calibrated to give 10 and 100 times the scale reading for small electrostatic charges.

ACOUSTICAL TESTS are being made to determine the effect upon plating methods as part of a general investigation by Western Reserve University, Cincinnati, Ohio. Results indicate that ultrasonic waves at 100 and 200 kc/sec produce structural changes in copper plated by the common acid sulphate type bath. They also decrease the potential associated with the plating process.

STRAIN GAGES THAT CAN BE TRIMMED as small as 0.01 in. wide and 0.14 in. long have been developed by Baldwin-Lima-Hamilton. New gages will enable strain measurements on very small pieces, or in cramped quarters.



THIS MONTH'S COVER

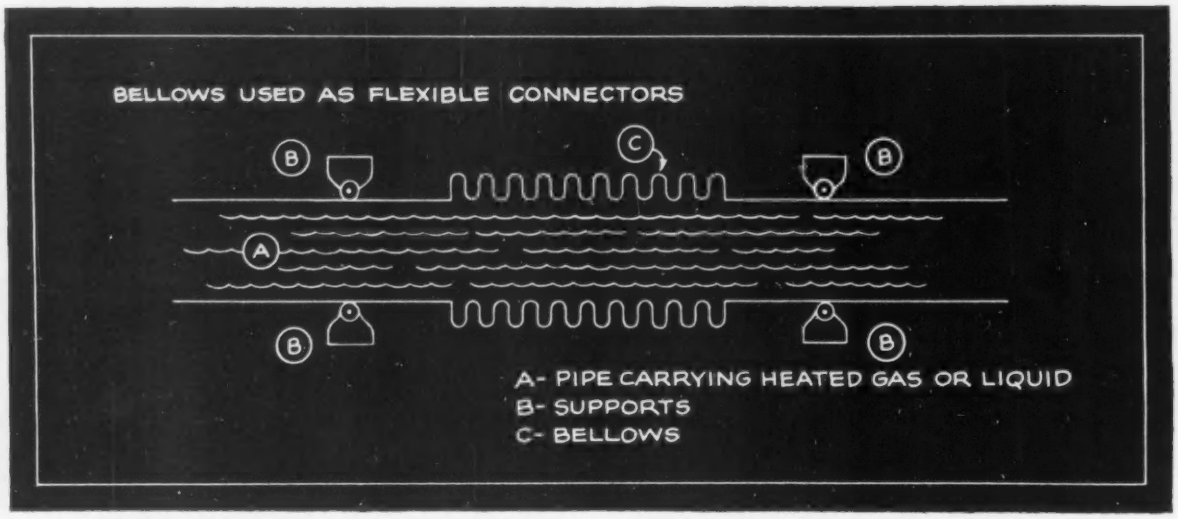
For the first time since 1940, automobile manufacturers face a stiff competitive market. Designers and stylists have mirrored this sales situation with 1953 models that boast fresh luxurious styling, higher horsepower engines, more rugged frame and chassis designs, and a long list of optional accessories to make driving easier.

Pictured on the cover are three cars that will vie for a piece of the prestige market—Buick, Lincoln, and Packard. They typify design trends in 1953 models. Buick celebrates its 50th anniversary with a new V-8 engine, the most powerful in its history; Lincoln will try for a bigger share of this market with changes that include a new 205 hp engine; and Packard has major engine and chassis changes.

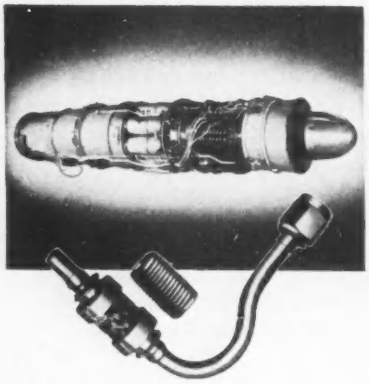
To see design details of these and 12 other 1953 automobiles, read the special Product Design Section starting on page 135.

Bellows Digest

No. 5. Bellows used for Flexible Piping

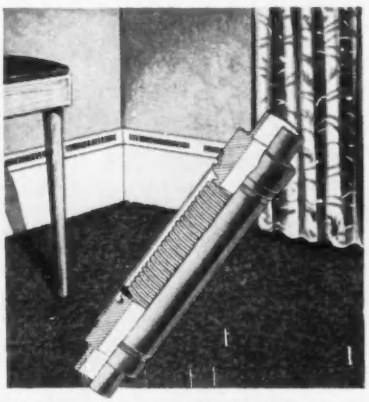


ONE OF MANY FLEXIBLE PIPING PROBLEMS solved by Clifford Hydron bellows is that of allowing for thermal expansion. Where heated gas or liquid would expand and buckle ordinary piping, the expansion or contraction of the flexible, leakproof bellows compensates for dimensional changes in the piping without imposing excessive strain on the supports. This also permits sidewise movement of supports with respect to each other. Another typical use of Clifford bellows as flexible joints is in hot-air de-icing ducts in airplane wings, where wing-flexing requires equivalent flexing of the ducts.



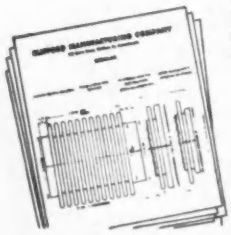
DESIGNED FOR JET ENGINES, Clifford's new flexible manifold assembly embodies a stainless steel bellows. Flexibility of the bellows withstands increasingly high temperatures, simplifies alignment problems, permits leakproof assembly of flare fittings and allows for thermal expansion.

FLEXIBLE JOINTS OF ANY DIAMETER from 7/8" to 26 3/4" are available with Clifford hydraulically formed stainless steel bellows. Made to desired specifications, they also serve many other applications where strength, flexibility, corrosion resistance and leakproof sealing are vital.



IN BASEBOARD RADIATION SYSTEMS, expansion joints incorporating Clifford bellows assure smoother operation, eliminating noise of pipes rubbing on timbers. Heating system makers also use Clifford bellows for steam traps, tank temperature control, mixing-valve thermostats, etc.

MAYBE YOU, TOO, CAN BENEFIT from the use of Clifford Hydron Bellows Assemblies. Besides their advantages as flexible joints in many types of applications, these flexible, leakproof, metallic bellows are also used to: (1) control and indicate temperature and pressure; (2) seal rotary shafts or packless valves against liquid or gas leakage; (3) transmit motion hydraulically to remote points; (4) provide shock mountings or vibration dampening; (5) permit motion in a vacuum.



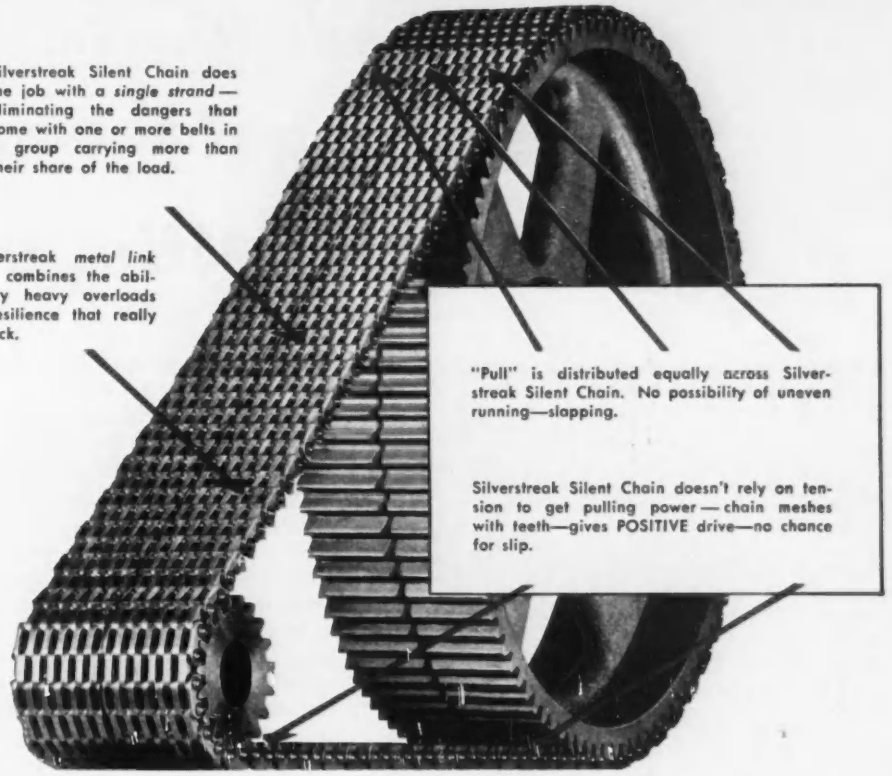
FREE! BELLOWS TEMPLATE KIT

Trace 20 most popular bellows sizes . . . fast . . . accurately. Kit in handy cardboard envelope, includes full directions and details of Clifford bellows. Simplify tedious jobs — send for your Kit today.

Write Clifford Manufacturing Company 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York 17, Detroit, Chicago 1, Los Angeles.

38.2.21

How to get Slip-proof Slap-proof Shock-proof power transmission at high speeds


Silverstreak Silent Chain does the job with a *single strand* — eliminating the dangers that come with one or more belts in a group carrying more than their share of the load.
Husky Silverstreak *metal link* construction combines the ability to carry heavy overloads with the resilience that really absorbs shock.
"Pull" is distributed equally across Silverstreak Silent Chain. No possibility of uneven running—slapping.
Silverstreak Silent Chain doesn't rely on tension to get pulling power — chain meshes with teeth—gives POSITIVE drive—no chance for slip.

Drive your machines the proven way — with LINK-BELT Silverstreak Silent Chain

Yes, get the amazing, trouble-free efficiency of 98.2%. A standard of operation that continues throughout the long, long life of the drive. More than this — every rating and design is backed by a record of *proven performance*. And every chain is engineered for the job. You conserve space, too—for Link-Belt Silverstreak Silent Chain Drives operate efficiently on short centers. Ratios as high as 10 to 1 are commonly used.

Little wonder, then, that so many concerns to whom top operation efficiency and rugged dependability are a must, standardize with Link-Belt Silverstreak Silent Chain Drives.

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities.

13,807

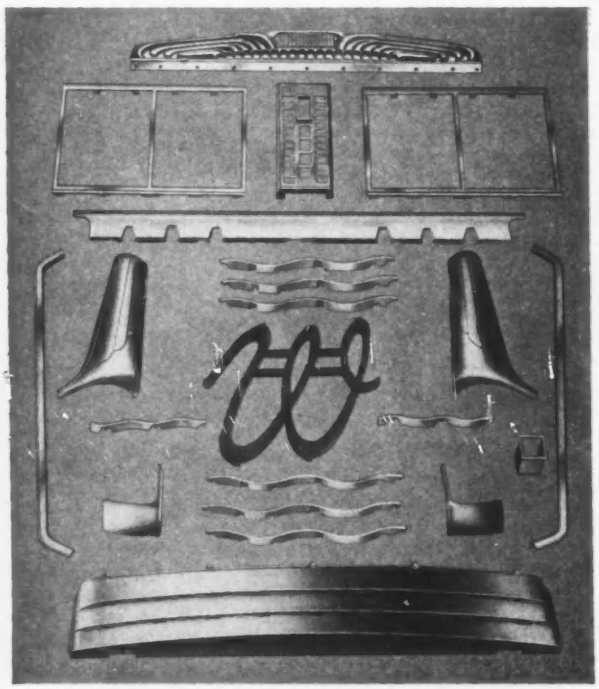
LINK-BELT

THE SYMBOL OF QUALITY — LB — LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES

take a cue from the

WURLITZER 1500 -get the mo$t for your Zinc Die Ca$ting Dollar!



Your design and production problems may be far removed from those entailed in the engineering of a coin-operated phonograph, but the use of ZINC Die Castings in styling the new Wurlitzer 1500 model might well be your cue to important manufacturing economies.

Glance at any one of the phonograph trim castings pictured here and ask yourself how else it could be produced in the required shape, with close tolerances, with clean-cut reproduction of detail and with a surface which could be electroplated or painted at low cost. In many instances, these pieces have dimensionally accurate cast mounting elements and cored openings which mean that an absolute minimum of secondary operations are needed to prepare the castings for close-fitting assembly.

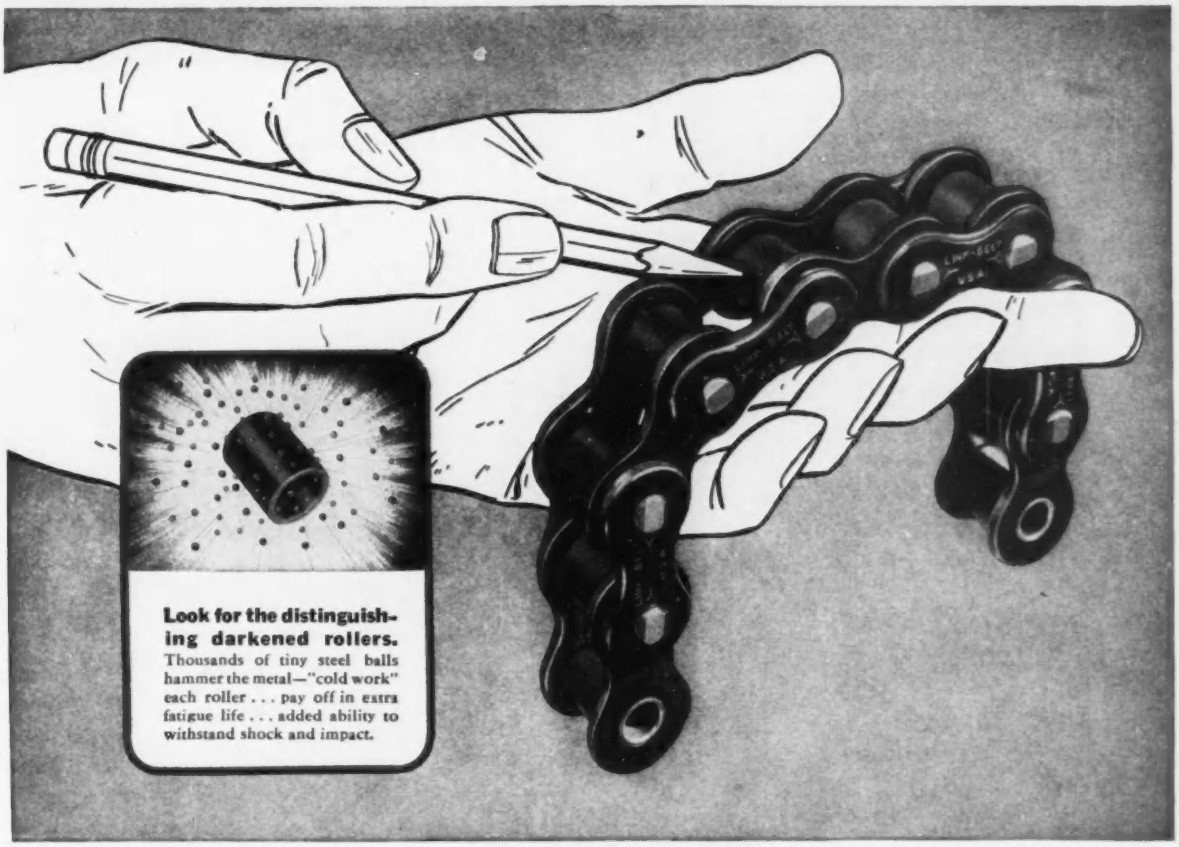
In ZINC Die Casting, the Wurlitzer engineers long ago found a metal and method of fabrication which offers complete freedom of design with impressive production savings. If *you* are not fully aware of the physical and economic advantages of ZINC Die Castings in product engineering it is suggested that you contact any commercial die casting company—or write to us.

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC


Look for the distinguishing darkened rollers.
Thousands of tiny steel balls hammer the metal—"cold work" each roller . . . pay off in extra fatigue life . . . added ability to withstand shock and impact.

It's the SHOT-PEENED rollers that give your roller chain extra life!

. . . one of the extra-wear features you get with every LINK-BELT Roller Chain

POWER-TRANSMISSION engineers and metallurgists agree—shot-peened rollers mean longer roller chain life. That's just one of the engineering extras you get with Link-Belt Precision Steel Roller Chain. Another is Link-Belt's exclusive lock-type bushing.

Remember, too, Link-Belt's rigid material selection and controlled heat treating assure chain uniformity . . . no weak members.

Link-Belt builds a complete line of roller chain—single or multiple widths in 3/8" through 3" pitch; and double pitch, 1" through 3". Submit your chain problems to the Link-Belt office near you.

No partial bearing here —bushing fits securely

Lock-type bushings increase ability to withstand severe operating conditions

A special manufacturing process securely locks the inside sidebars on the bushing, preventing lateral movement of the sidebars and eliminating a common cause of stiff chains. This Link-Belt development is applied on roller chains through 1" pitch and double pitch roller chains through 2" pitch.

LINK-BELT

Precision Steel Roller Chain

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices, Factory Branch Stores and Distributors in Principal Cities. 12,805

TODAY...

the quality of mercy is strained!

REYNOLDS WIRE

protects performance

● Just a bottle... and a tube... with blood plasma flowing slowly into the veins of a wounded man on the battle field... to save that man from almost certain death. And on that indispensable life line... a tiny blood plasma strainer made of Reynolds Wire Cloth. Small in size; big in performance. Not quite so dramatic, or so vital, are the many other *for-defense* uses of Reynolds Wire Cloth—in the production of high octane aviation gasoline... in making gunpowder... in radar reflective tow targets... and, of course, the tremendous number of Reynolds Wire Cloth applications in Agriculture, in Aviation, and the Automotive Industry—so essential in sustaining the defense and civilian economies of our nation in peacetime or in wartime. Reynolds combines 50 years' wire-weaving experience with modern facilities. Consult Reynolds engineers. No obligation.

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., DIXON, ILLINOIS

NS NATIONAL-STANDARD Company NILES, MICHIGAN

DOUBLED BELT LIFE

by consulting Goodyear Distributor

OPERATOR of this granite gang saw called a Goodyear Distributor for help with his flat belt drive. The Distributor came, bringing along the G.T.M.—Goodyear Technical Man—to analyze the drive and make belt recommendations.

The G.T.M. studied the drive, made his engineering recommendations, specified the belts to handle the problem. Result: the COMPASS Flat Belts he recommended delivered two years' service—*double the best previous record*. The Distributor took over—now stocks the exact replacement belts the operator needs—can deliver them right out of stock at any time.

You can get service like this, too—specification of the *right* product and on-call delivery—simply by calling your nearest Goodyear Industrial Rubber Products Distributor. Look for him in the yellow pages of your Telephone Directory—handling Hose, Flat Belts, V-Belts, Packing, Tank Lining, Rubber-Covered Rolls—or write for an introduction to Goodyear, Mechanical Goods Division, Akron 16, Ohio.

Compass—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

HERE'S WHY IT PAYS TO ORDER FROM YOUR LOCAL GOODYEAR INDUSTRIAL RUBBER PRODUCTS DISTRIBUTOR

Replacement orders filled when you need them from convenient, local stocks.

One order, *one* bill, *one* central responsibility for all your Mechanical Goods requirements.

You save on valuable stockroom space, because your local Distributor maintains a full stock of what he knows you need.

Double assurance of satisfaction because the Distributor and Goodyear stand behind the products he sells you.

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like "THE GREATEST STORY EVER TOLD"—every Sunday—ABC Radio Network THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

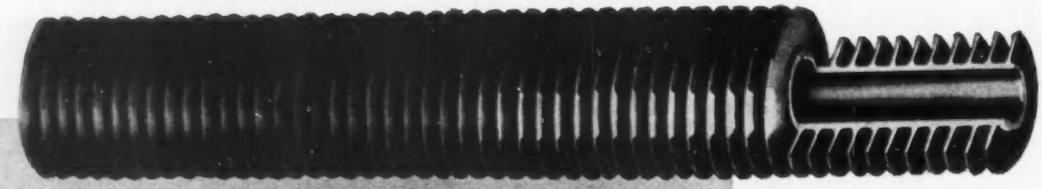
LOOK!

THE FINS OF WOLVERINE TRUFIN* HAVE BEEN SQUEEZED

right out of the tube wall

They are the tube itself—the fins and the tube are integral.

Thus they can withstand vibration and sudden temperature changes—assuring full efficiency at all times.



Trufin is available in (1) a variety of alloys, (2) in fin spacings 5, 7, 9, 11, 16 and 19 fins to an inch and (3) in a range of inside diameters from 5/16" to 1".

Also available in bi-metal with an integral fin construction and different metal lining.

Ask for our new Catalog 201 that will give you more detailed information. If you have an immediate problem dealing with heat exchangers we invite you to call our Customer Engineering Service which can offer much helpful information.

*REG. U. S. PAT. OFF.

WOLVERINE TUBE DIVISION

of Calumet & Hecla, Inc.

Manufacturers of tubing exclusively

1415 Central Ave. Detroit 9, Mich.

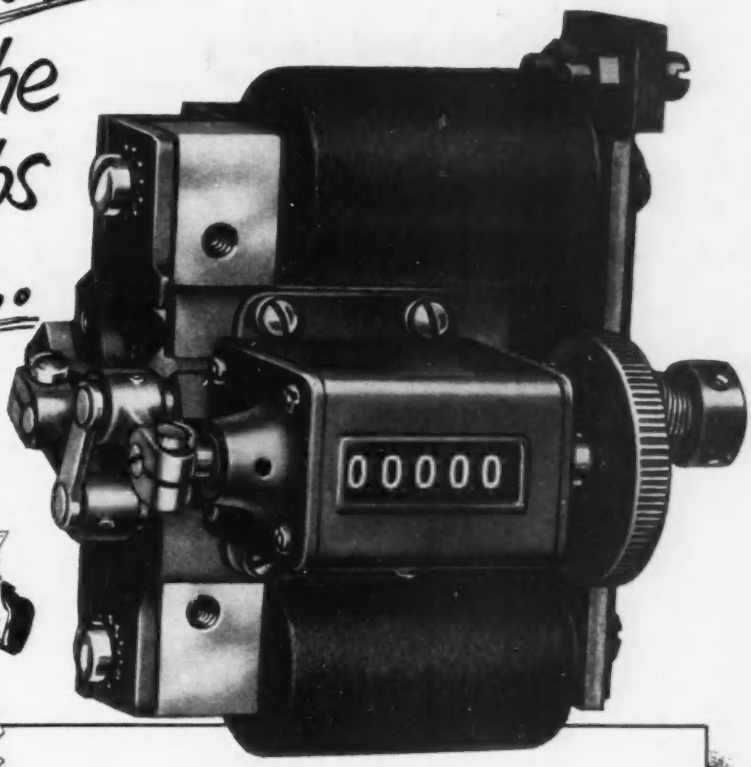
Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA

Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

This Electrical Reporter Stays on the Tough Jobs Longer...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Compact and rugged . . . this electrically operated reset counter is specially designed for tough jobs that demand longer counter life.

Here's another instance of the *infinite applicability* of Veeder-Root *Count*rol — electrical, mechanical or manual. And here's another instance, too, of the endless resourcefulness of Veeder-Root engineering, and the ability to design a *complete counting package* that fits the job fully and exactly. Now . . . what's *your* problem?

VEEDER-ROOT INCORPORATED

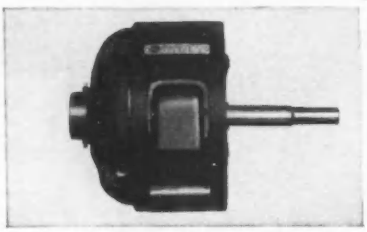
"The Name That Counts"

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N.Y. • Greenville, S.C
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

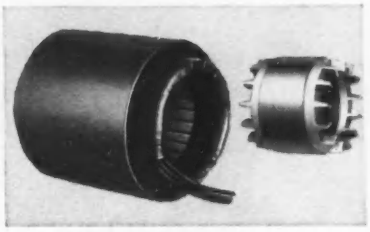
Designer's

Special-purpose Tri-Clad* motors simplify your design job



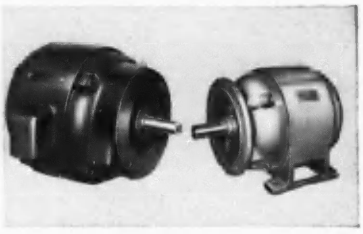
PARTIAL MOTORS
can be built right in

Compact, simple, and efficient, Tri-Clad partial motors can be supplied less drive-end end shield and bearing, as shown, for direct coupling; or less shaft, both end shields, and bearings for building right into your machines.



SHELL-TYPE MOTORS
have high hp in small space

Here a shaftless rotor and shell-like stator with punchings and windings provide high speeds and high hp in small space. Used for "built-in" applications on equipment such as boring machines, tapping machines, and grinders.

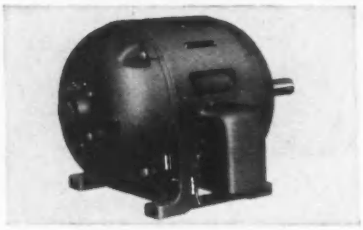


FACE- AND FLANGE-TYPE MOTORS
cut your assembly costs

Mechanical modifications of standard Tri-Clad motors include both face-type and flange-type end shields. Either type motor and your machine are quickly bolted together, minimizing assembly time and expense.

UNIT BRAKE-MOTORS
save space on your machines

Space-saving and easy to order, Tri-Clad brake-motors for holding and stopping loads combine motor and Stearns magnetic brake in one unit. Available with most types of Tri-Clad motors in ratings up to 20 hp, 90 lb-ft static torque. See Bulletin GEA-5464.



MULTI-SPEED AC MOTORS
provide up to 4 speeds

Specify Tri-Clad multi-speed motors where two, three, or four different operating speeds are necessary. In ratings from 1 to 200 hp at 1800 rpm, they're available as constant-torque, variable-torque, or constant-horsepower motors.

VERTICAL MOTORS
are easy to interchange

For direct mounting on tools, indoor pumps, etc., Tri-Clad vertical motors have standard NEMA base dimensions that make them easy to install or interchange. Available from ½ to 125 hp in standard frequencies and pole combinations. See Bulletin GEA-4033.

*Reg. Trade-mark of General Electric Company

Where specific bulletins are not listed, your G-E apparatus representative can supply further information. G-E Tri-Clad open motors are covered in Bulletin GEA-3580.

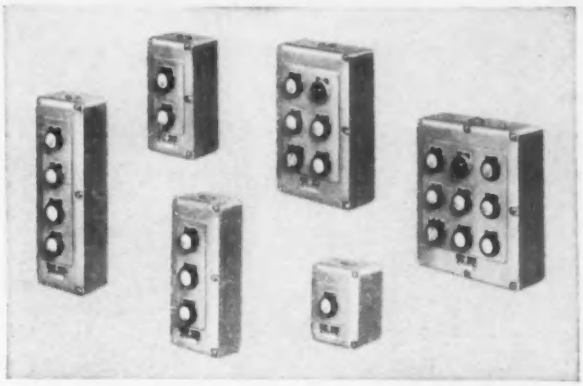
GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

INTERCHANGEABLE HEADS, 4-WAY MOUNTING MAKE THESE LIMIT SWITCHES VERSATILE

Designers find the complete G-E line meets all their limit-switch needs. Take G-E track-type switches (shown), for example: four interchangeable heads for standard body meet a variety of applications. Each head can be mounted in any of four positions 90 degrees apart, making 16 combinations. For full data on G-E limit switches, check Bulletins GEA-5707 (track type), GEA-5705 (lever-type), GEA-5704 (rotating type).



New oiltight push-button stations offer variety of unit combinations

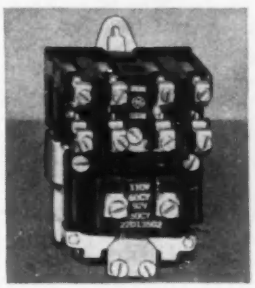
An example of the design flexibility that marks General Electric's new oiltight push-button line is the variety of stations available. Specify any combination of units from one to nine, factory-mounted in one compact station, or order enclosures and units separately.

Enclosures, designed in accordance with JIC standards, are made of strong, light cast-aluminum for use wherever oil or coolant is present. Buna-n gaskets resist deterioration, won't stick to enclosure, so can be used over and over again.

These surface-mounted enclosures accommodate the new line of G-E oiltight units that feature one basic type of contact block, a full selection of interchangeable operators, and interchangeable color rings for easy coding. Check Bulletin GEA-5779.

MAXIMUM COVERAGE, MINIMUM STOCK: SIZE 00 CONTACTORS AND RELAYS

Available in any combination of normally open and normally closed contacts from 2 to 8 poles, G-E size 00 contactors and relays cover almost every control-circuit relaying need. Contact tips are easily changed from NO to NC without extra parts, reducing your stock of specials. Accessible terminals accommodate up to three wires, are designed for fast wiring. Your G-E apparatus representative has full details.



EASY TO INSTALL ON YOUR MACHINES: CONTACTORS AND MOTOR STARTERS

These features of G-E magnetic starters which make them easy and inexpensive to install and connect: Front-of-panel terminals, three-point keyhole mounting of enclosures, terminal clamps that follow screws out, pan-head terminal screws, plenty of wiring room. These features, plus top starter performance, mean better products, lower costs when you specify G-E magnetic starters. Bulletin GEA-5154.

General Electric Company, Section C668-98
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes × for immediate projects

- ☐ GEA-3580 Open Motors
- ☐ GEA-4033 Vertical Motors
- ☐ GEA-5154 Magnetic Contactors
- ☐ GEA-5464 Brake-Motors
- ☐ GEA-5704 Rotating-Type Switches
- ☐ GEA-5705 Lever-Type Switches
- ☐ GEA-5707 Track-Type Switches
- ☐ GEA-5779 Push-Button Stations

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____

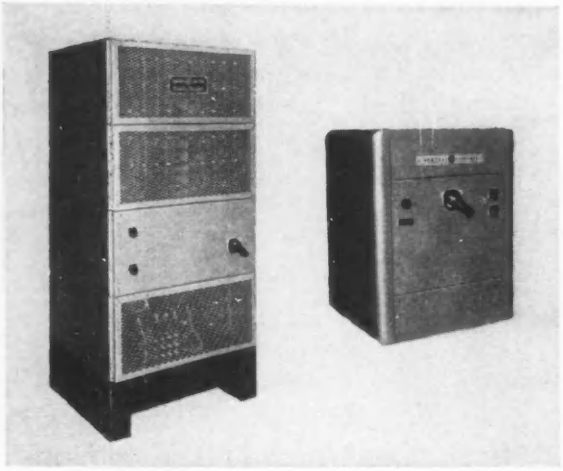
COMPANY_____

STREET_____

CITY_____ STATE_____

TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

EASILY SPECIFIED, QUICKLY INSTALLED: PACKAGED METALLIC-RECTIFIER UNITS

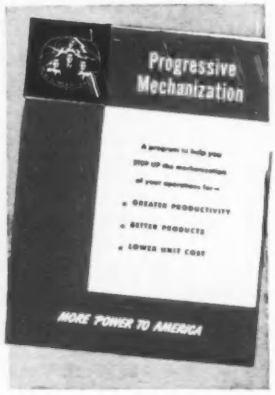


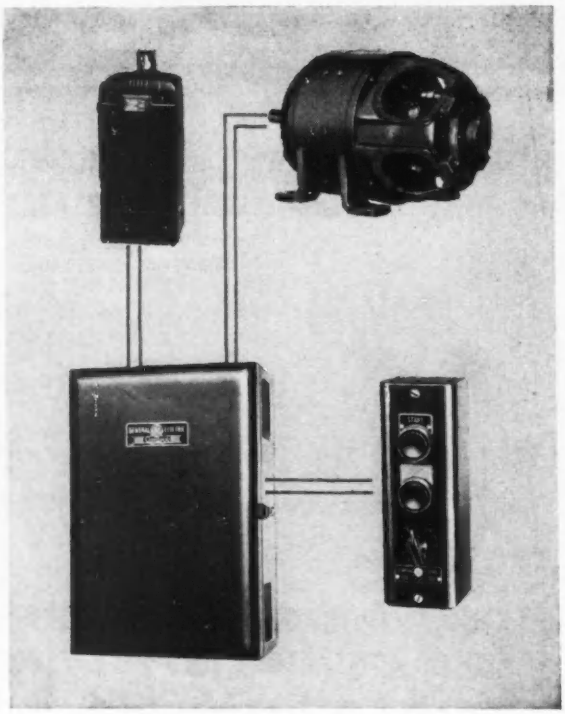
If the machines you build require metallic rectifiers, specify General Electric packaged units for convenience, low installed cost, and minimum user maintenance. Specifying is easy: each metal-enclosed unit comprises selenium rectifier stacks, insulated transformer, and controls. Quickly installed, the compact units need no special foundations, save floor space (25-kw unit at left is only 25 x 31 x 65⅛ inches). Single-unit ratings from 0.75 to 25 kw (125 and 250 volts d-c), complete installations up to 300 kw. For complete description of this line plus simple guide-form specifications, check Bulletin GEA-5658.

PROMOTES LONG-RANGE MACHINE SALES: PROGRESSIVE MECHANIZATION PROGRAM

"Progressive Mechanization," General Electric's new More Power to America Program, offers industry a planned, step-by-step approach to greater mechanization—from simple machines up through improved machines, automatic control, and continuous process.

Addressed to *your* customers, it can promote new long-range sales for your machines as a means to increased productivity, better products, lower manufacturing costs. Program includes sound-color movie, "how-to" manual, and survey form, all described in Bulletin GEA-5789.





Basic features in smaller size — new G-E adjustable-speed drive

Now you can build increased versatility into your machines with a simplified, lower-cost G-E Thy-mo-trol* adjustable-speed drive that includes all the features needed for a variety of machine tools, conveyors, pumps, etc. With a control panel half the size of more precise models, this new drive provides smooth, stepless speed control at the turn of a knob, pre-set speed control, and ±3% speed regulation.

Ratings of these new drives are ¾, 1, 1½, 2, and 3 hp, in speed ranges of 5:1 and 20:1 (1750/350 rpm and 1750/88 rpm). Power supply is 220/440 volts, 50/60 cycles. Both reversing and non-reversing forms are available. Drive components include anode transformer, d-c motor, operator's control, and electronic panel (latter also made in open form for building-in).

Also available are improved, precision ¾ to 10 hp G-E Thy-mo-trol drives with additional features, plus other ratings in the full line ranging from 1/40 to 75 hp. New ¾ to 3 hp line is described in Bulletin GEA-5829.

*Reg. Trade-Mark of General Electric Company.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

CUTS WASTE, ASSURES UNIFORMITY: PROCESS TIMER FOR REPEAT CYCLES

General Electric Type TSA-14 process timers are used to repeat continuously cycles of open and closing contacts where percentage of "on" time of double-throw contacts must be adjustable. On such repeat-cycle applications (sample use: to control intermittent lubrication on milling machines) they reduce waste, assure uniform operation, save machine-operators' time.

Total time cycles, ranging from 10 seconds to 8 hours, are set during manufacture. Percentage of "on" time can be varied by user. Telechron* motor assures accuracy. Pipe nipple simplifies mounting in any convenient knockout, and flexible color-coded leads facilitate wiring. Circuit arrangement: single pole, double throw. Size: 5 in. in diameter, 3⅛ in. deep. Operates at 25, 50, or 60 cycles, 115 or 230 volts. For full description, see Bulletin GEC-525.

PRACTICAL FOR HIGH-COST COMPONENTS: ULTRASONIC SMALL-PARTS CLEANER

If you face the problem of cleaning small, expensive components, here is a practical answer—the General Electric ultrasonic cleaner. Quickly, thoroughly, it removes oil, grease, chips, dirt, lapping compounds, and other contaminants from surfaces, corners, and small holes of precision-built, irregularly shaped work pieces. Time, labor, and floor space are saved.

Equipment comprises an electronic power unit (essentially a high-frequency oscillator) in a 45-inch-high cabinet. Above it is a transducer assembly, with a quartz crystal in a 4-inch diameter well. Parts are dipped in a suitable cleaning solution in this well and subjected to ultrasonic energy. Operation is at 300 kc, 500 kc, 750 kc, or 1 megacycle. Power input is 500 watts at 115 volts, 50/60 cycles. See Bulletin GEA-5669.

Electric heaters go in fast, work accurately and reliably

In machines built for controlled compressive shrinking of cloth, a New Jersey manufacturer uses dozens of General Electric cartridge heaters to provide the accurate, easily controlled heat needed for the process. This company has found that, besides being reliable and convenient, electric heat is quickly installed, since workmen need only insert the heaters and connect the leads.

For the heat-requiring machinery *you* build—packaging, textile, printing, bottling, labeling, or extrusion machines—specify G-E Calrod* heaters for clean, convenient heat. Illustrated 64-page booklet describes the full G-E line, including immersion, strip, cartridge, tubular, unit and fin heaters. Prices and application data are included. See Bulletin GEC-1005.

General Electric Company, Section C 668-99
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes X for immediate projects

- ☐ GEA-5658 Metallic Rectifiers
- ☐ GEA-5669 Ultrasonic Cleaners
- ☐ GEA-5789 Progressive Mechanization
- ☐ GEA-5829 ¼ to 3 hp Thy-mo-trol
- ☐ GEC- 525 TSA-14 Timer
- ☐ GEC-1005 Electric Heaters

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____

COMPANY_____

STREET_____

CITY_____ STATE_____

You wouldn't
finish grind
a cotter pin

Why pay for unneeded precision in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency!*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6758 Fairview Avenue, Poughkeepsie, New York

Schatz "Commercial" Bearings used on these products

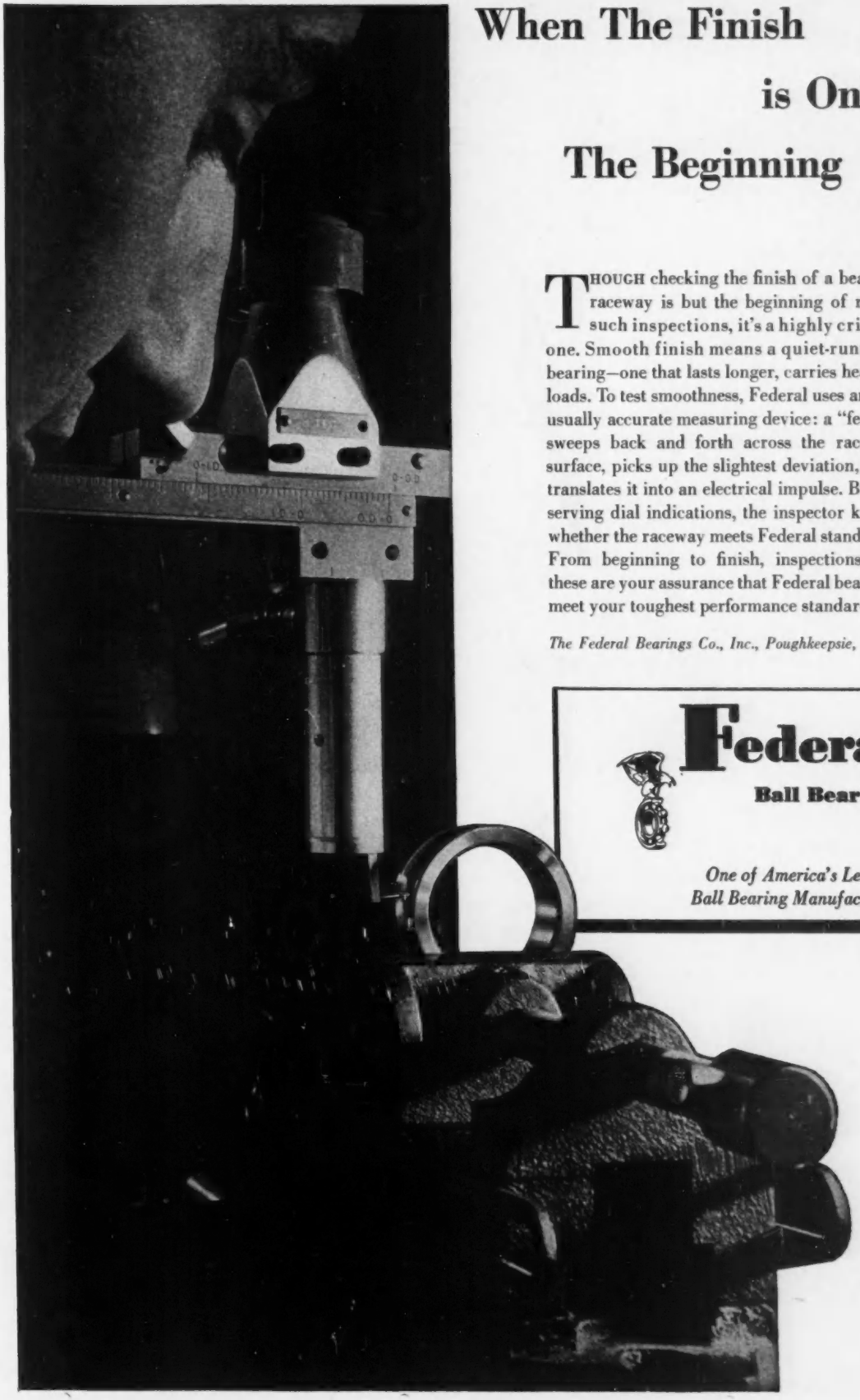
Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
Textile machinery • Farm equipment
Laundry equipment

What about your product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ
"Commercial"
BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.



When The Finish is Only The Beginning

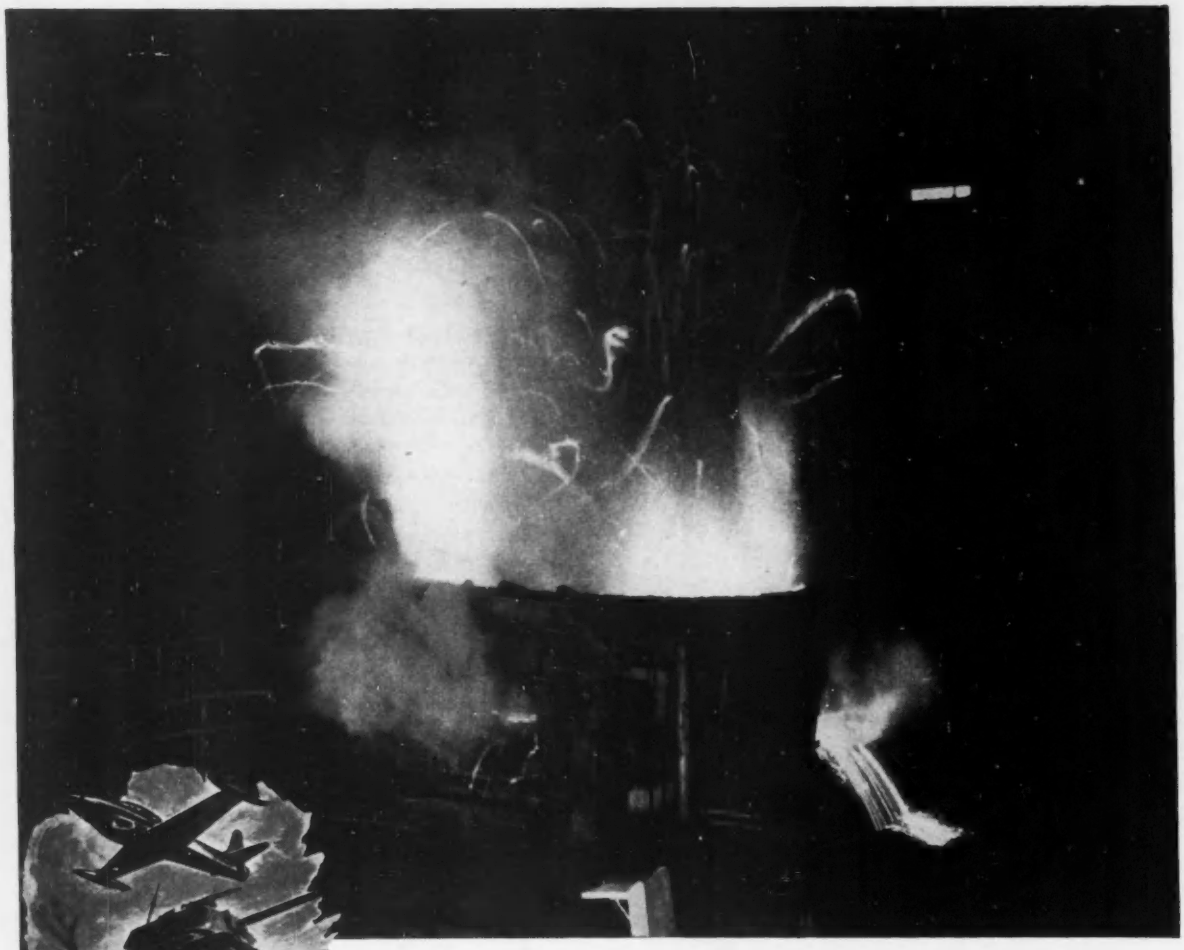
THOUGH checking the finish of a bearing raceway is but the beginning of many such inspections, it's a highly critical one. Smooth finish means a quiet-running bearing—one that lasts longer, carries heavier loads. To test smoothness, Federal uses an unusually accurate measuring device: a "feeler" sweeps back and forth across the raceway surface, picks up the slightest deviation, then translates it into an electrical impulse. By observing dial indications, the inspector knows whether the raceway meets Federal standards. From beginning to finish, inspections like these are your assurance that Federal bearings meet your toughest performance standards.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal

Ball Bearings

One of America's Leading Ball Bearing Manufacturers



Special Steels for Armament for Industry for the Home

Spectacular Beginning of a SPECTACULAR STEEL

An electric furnace puts on a terrific show when we drop in a charge (as above) but it's only indicative of the great performance the steel will give later in service. For these are the high-alloy steels, stars of the metal world . . . the steels that give you so much more than they cost in resisting corrosion, heat, wear or great stress—or in providing special electrical properties. ● They can help *you* cut costs, improve quality, or add sales appeal. Let's get together on it. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

WBD 4145 B

PIONEERING on the Horizons of Steel

Allegheny Ludlum

AL
LEADING PRODUCER HIGH-ALLOY STEELS

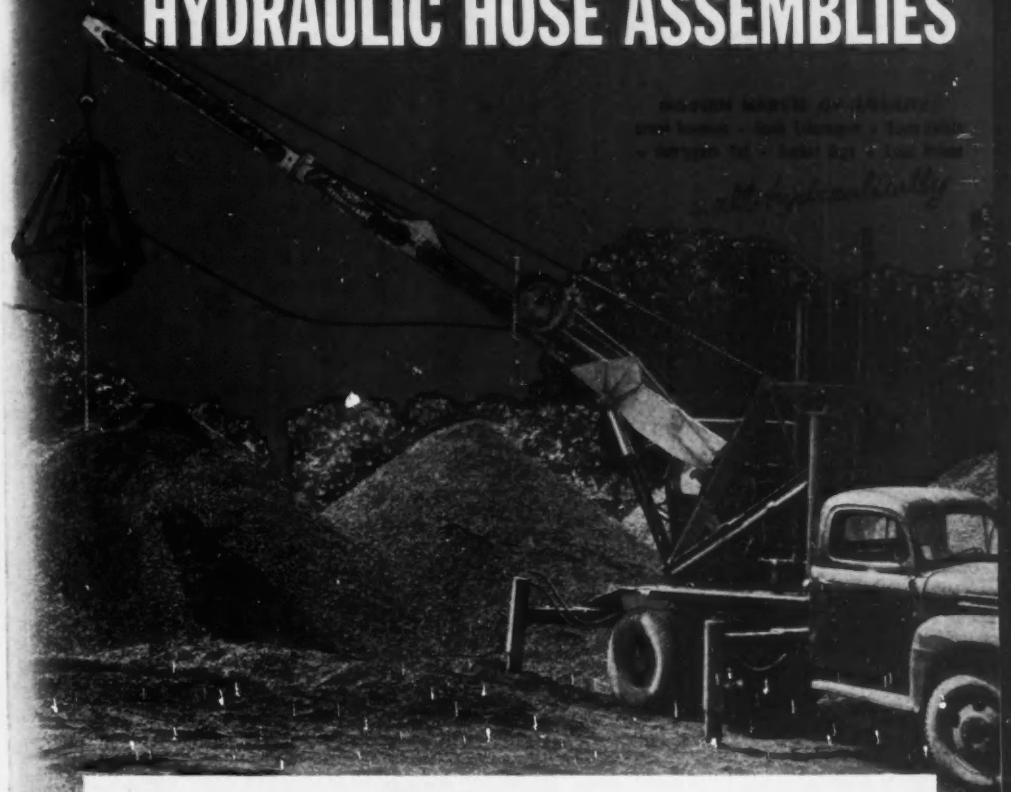
SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

6 HYDRAULIC MOVEMENTS OF BUCYRUS-ERIE HYDROCRANE RECEIVE POSITIVE POWER THROUGH...

Eastman

first in the field

HYDRAULIC HOSE ASSEMBLIES

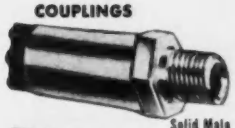


specify

Eastman
first in the field
HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS



Solid Male

Swivel Male

Swivel Female

HOSE

1-Wire Braid Hose

2-Wire Braid Hose

1-Fabric Braid Hose

2-Fabric Braid Hose

Spiral Wire Hose

Write

for free catalog 100 on Eastman hose couplings and fittings.

Positive, unfailing hydraulic power is delivered to six basic motions on many Bucyrus-Erie H-3 Hydrocranes through dependable Eastman Hydraulic Hose Assemblies.

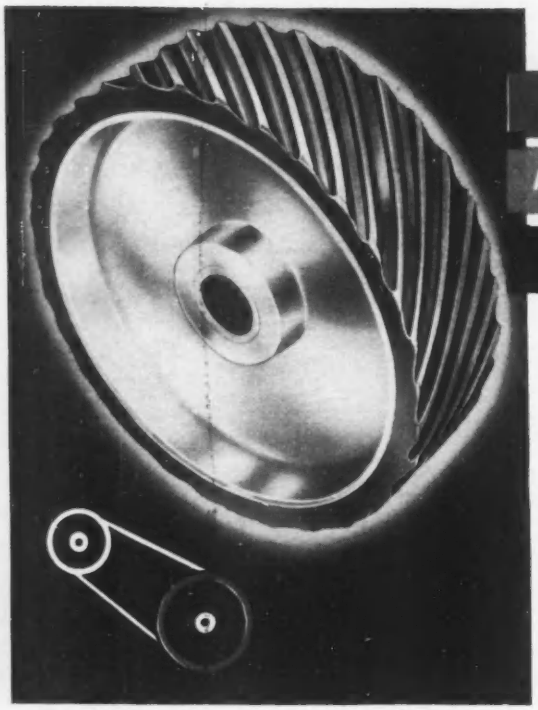
Eastman, *first in the field* of Hydraulic Hose Assemblies, pioneered in many original applications of mobile hydraulic power. As early as 1926, J. Peter Eastman experimented with wire braided hose.

Continued Eastman developments have made it possible to apply *more* power, over *greater* distances, through *higher* pressures—until today, 6,500 psi are withstood by the Eastman 3-wire braid hose assemblies used on many Bucyrus-Erie H-3 Hydrocranes.

Take advantage of our 25 years of experience in the application of mobile hydraulic power to manufacturer's original equipment. Engineering consultation on special problems is our specialty . . . complete service yours to command.

Eastman
MANUFACTURING COMPANY
Since 1914
Dept. PT2, Minneapolis, Minn.

Neoprene's outstanding properties



HEAT RESISTANCE

ABRASION RESISTANCE

OIL RESISTANCE

These properties of neoprene increased the efficiency of this

CONTACT WHEEL

The serrated neoprene surface of this new type of contact wheel for abrasive belt applications means longer belt life, faster stock removal, and more uniform finishing. The flexing action of the resilient face constantly varies the grinding angle of the abrasive particles . . . thus reduces "glazing," enemy of long and productive belt service.

Neoprene does not soften or weaken from high frictional heat . . . resists abrasion, cutting and chipping. What's more, it withstands attack from grease and oils.

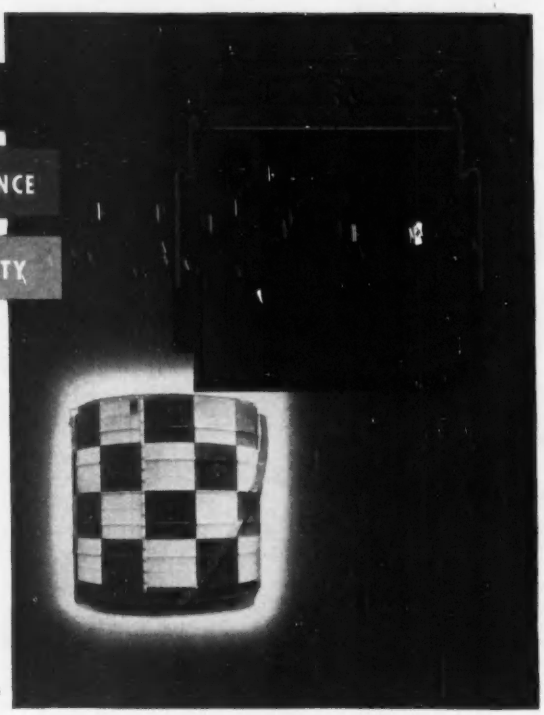
The Carborundum Company, Niagara Falls, New York

These properties of neoprene lengthened the service life of this

FLEXIBILITY

CHEMICAL RESISTANCE

LOW PERMEABILITY



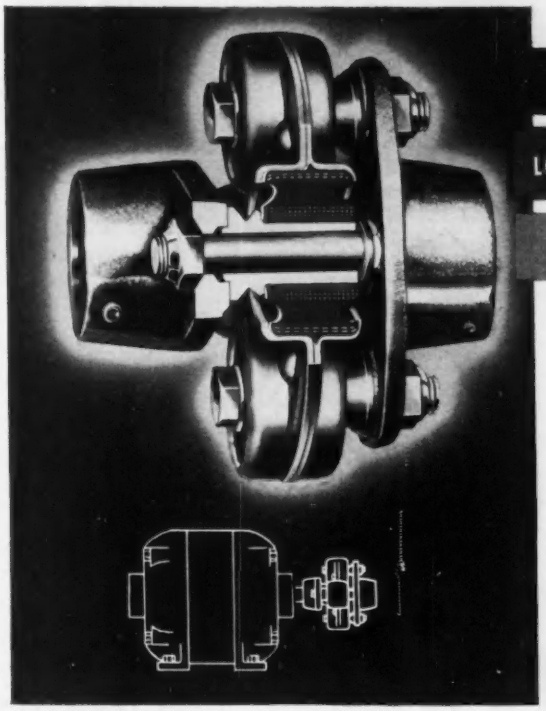
GASHOLDER

A cover of woven asbestos coated with neoprene acts as a "dry seal" in this gasholder for the storage of petroleum vapors, and chemical process and industrial gases. As gas is fed into the gasholder and the frictionless floating piston rises, the flexible seal rolls off the telescoping fenders and onto the outer shell.

Neoprene is an excellent coating material because of its low permeability, resistance to chemical attack and long-lasting flexibility.

General American Transportation Corp., Chicago, Ill.

meet exacting design requirements



OIL RESISTANCE

LOW COMPRESSION SET

RESILIENCE

These properties of neoprene simplified the design of this

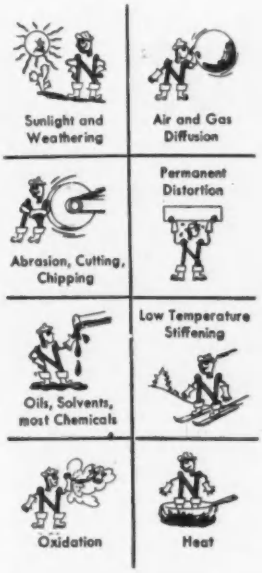
FLEXIBLE COUPLING

Power is smoothly transmitted between two shafts by this improved coupling, even under conditions of extreme misalignment. Four neoprene "biscuits," designed for uniform deflection, compensate for difference in shaft positions . . . provide the coupling with exceptional flexibility . . . isolate vibration and absorb shock loads.

Neoprene was selected for this important role because of its low compression set, an essential property for good vibration dampening characteristics. And neoprene's oil resistance and excellent flex resistance assure long service life.

Morse Chain Co., Detroit, Michigan

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



Make Your Design a Success!

In products like these, and in countless others, the use of properly compounded neoprene solved tough problems in design. Check over the list of neoprene's properties. If one or a combination of these properties is important in your product design, write us for complete technical data. Although Du Pont does not make any finished products of neoprene, our engineers will be glad to work with you and your rubber goods supplier on your individual problem. Write to: E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Div. E-12S, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.

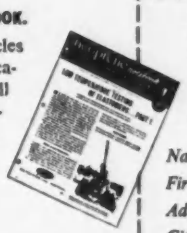
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

NEOPRENE

The rubber made by Du Pont since 1932

FREE! THE NEOPRENE NOTEBOOK.

Each issue contains articles about new, unusual applications of neoprene that will help you design new products . . . improve old ones. Mail the coupon today so that you won't miss a single issue.



E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division B-2
Wilmington 98, Delaware

I am interested in receiving the Neoprene Notebook regularly.

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

PARKER-KALON®

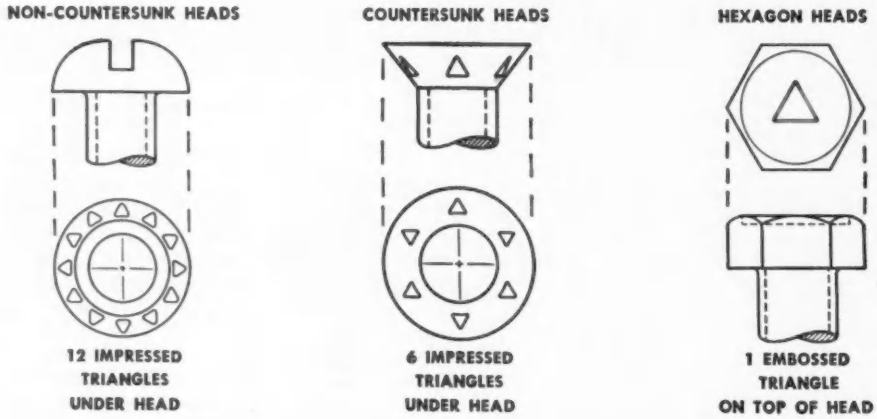
The Original

SELF-TAPPING SCREWS

NOW...

Signed

For Your Protection



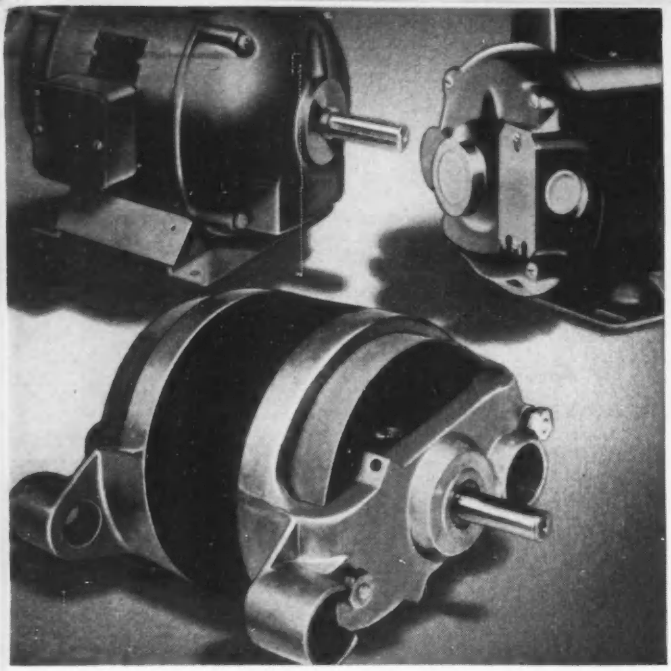
Signed Like the hall mark on fine silverware, this triangle mark now impressed on all P-K Self-tapping Screws signifies the maker's pride of craftsmanship. This "signature" will serve for your protection against substitution.

Certified Now, the P-K triangle mark will certify every screw that bears it as a genuine Parker-Kalon product, made by the *originators* of Self-tapping Screws. Now, you can be sure, when you see this mark, that you are using the *only* Self-tapping Screws made with the accumulated "know-how" of 40 years of enterprising leadership.

Guaranteed Now, identification goes beyond boxes or other containers and labels. The screw identifies itself, and when you see the P-K triangle mark you know it is the *guaranteed* screw, backed by the "Guarantee of Highest Quality" printed on every box. Look for the P-K triangle on the screws you buy and use. It's your one sure way to guard against job-slowing, parts-wasting screw failure . . . the way to make *planned* assembly savings *pay off*. Parker-Kalon Corporation, 200 Varick St., New York 14.

IF IT'S P-K IT'S O.K.

TRADE MARK.
REG. U.S. PAT. OFF.



Complete Motors... or Motor Parts

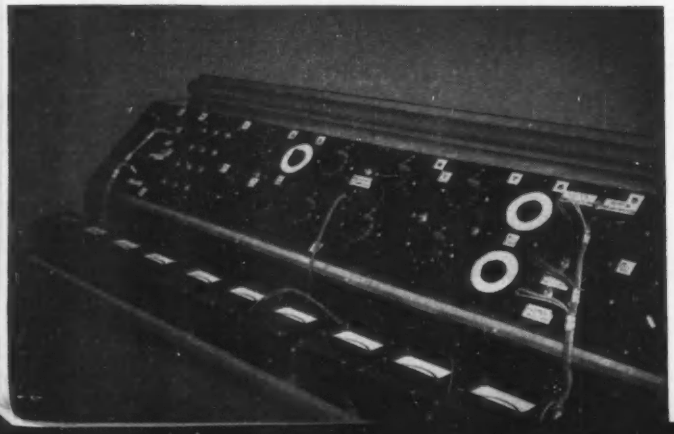
Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*



You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

ROBBINS & MYERS, INC., MOTOR DIVISION,
Springfield 99, Ohio:

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

*Product we manufacture:*_____

*Name*_____ *Title*_____

*Company*_____

*Street*_____

*City & State*_____

R&M MAKES BOTH!
Fractional horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, *it's the Right Motor!*

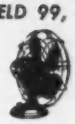
Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 125 h.p.

*"*All-Weather*" *is an R&M trademark*

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

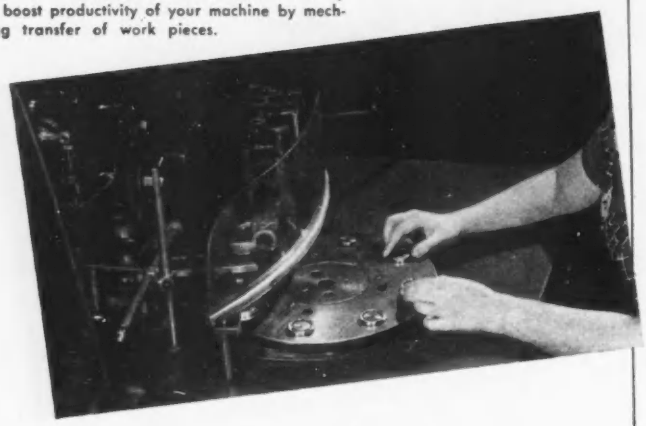

Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

Feed-O-Matic cuts time required for a secondary dieing operation from .210 of a minute per piece to .046 of a minute. Feed-O-Matic conceivably could boost productivity of your machine by mechanizing transfer of work pieces.



Ideas for 1960 .... or sooner

A mechanical hand designed to feed parts into punch presses can be "trained" to do the same job **wherever precision feeding is desired under difficult or dangerous conditions.**

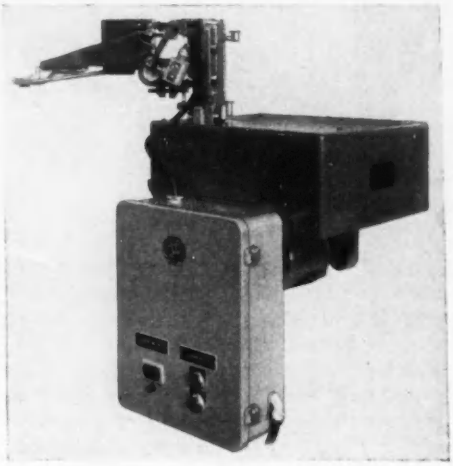
The Feed-O-Matic "mechanical hand" has added safety, speed and certainty to punch press operations. It can do as much for other machines. Its applications are a challenge to design engineers. With the Feed-O-Matic your 1960 model designs can come into being right now.

Need precision, greater safety or more speed in work-piece pickup, placement and/or transfer on your equipment? Feed-O-Matic may have the answer.

Feed-O-Matic picks up and then places tricky shapes into die with precision and speed. You may be able to apply its mechanized "manual" dexterity to automate your machine.

THE FIELD OF USEFULNESS IS WIDE OPEN RIGHT NOW

We have not worked out Feed-O-Matic design details for every possible application. But our engineers will be glad to work on them with you for *your* applications.



1. SAFETY

No part of any human body need even approach a danger zone. For eye hazardous conditions the Feed-O-Matic need not even be in sight.

2. SPEED

The Feed-O-Matic is synchronized with the machine it serves. It wastes no motions, never gets tired.

3. CERTAINTY

Precision pickup and placement of parts, and if desired, automatic shut-off of power if anything fails to function properly, are only two of the features that cause the Feed-O-Matic to add certainty to machine operations.

FEED-O-MATIC BROCHURE describes use of this device in secondary die operations. Will give you details on its basic principles. Please write Dept. P for your copy.

Only the best is good enough

THE V & O PRESS COMPANY

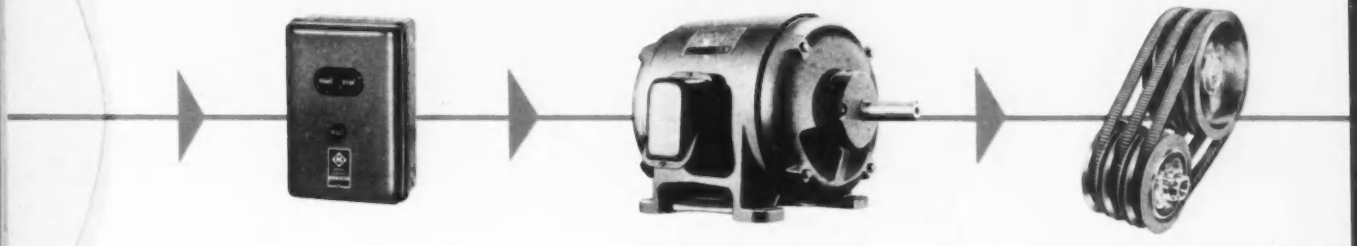
DIVISION OF EMHART MFG. CO.

HUDSON, NEW YORK

Builders of Precision Power Presses and Feeds Since 1889

One Reliable Source for . . .

Everything from Power Line to Driven Shaft



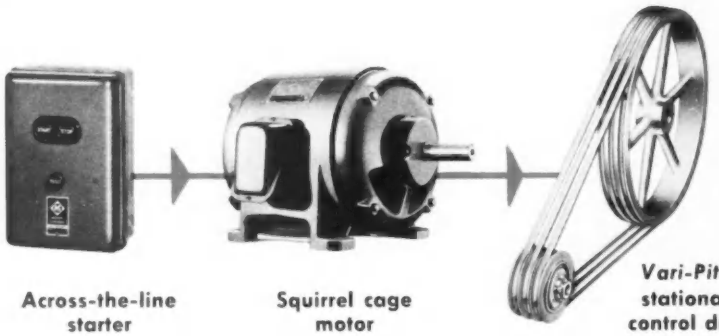
Control **Motor** ***Texrope* V-belt Drive**

A-3955

Eight Ways to Get

Mechanical

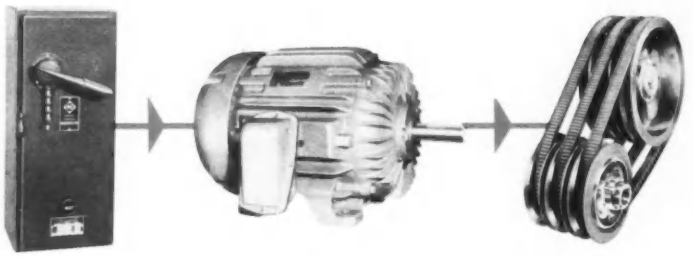
Economical variable speed for many applications where speed range required is not too great and where the machine may be stopped to make speed changes. Two *Vari-Pitch* sheaves used together double range of adjustment. Horsepower range — 1½ to 300. Speed adjustment range — 9 to 28 percent.



Across-the-line starter | Squirrel cage motor | *Vari-Pitch* stationary control drive

Mechanical

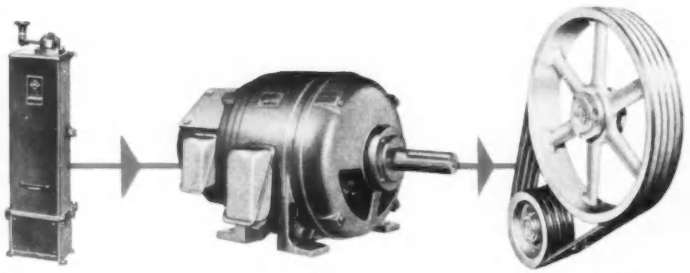
Popular for textile machinery and other machines where considerable speed adjustment is required. Available for either stationary or motion control. When both are *Vari-Pitch* sheaves, adjustment range is doubled. Horsepower range — 1½ to 40. Speed adjustment range — 2 to 1.



Combination starter | Squirrel cage motor | *Vari-Pitch* wide range drive

Electrical

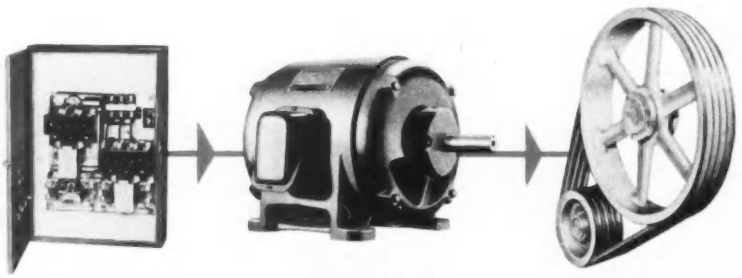
Speed is varied by means of control on secondary windings of motor. Speed control by steps, but in larger sizes can be stepless type using liquid regulator. Horsepower range — 5 hp and up. Speed adjustment range 50% of synchronous speed to full synchronous.



Wound rotor control | Wound rotor motor | *Texrope* V-belt drive

Electrical

Motor is built in standard squirrel cage frame with special windings and control. Up to four speeds available from one motor. Furnished with variable torque, constant torque or constant horsepower. Horsepower range — ½ hp up.



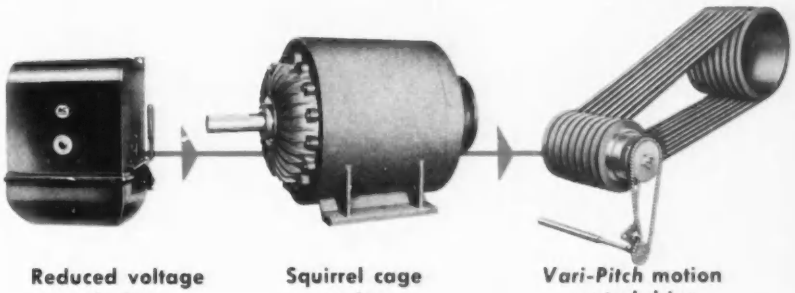
Multi-speed motor starter | Multi-speed squirrel cage motor | *Texrope* V-belt drive

COMPLETE DRIVES *from One Reliable Source —*

Variable Speed Drives...

Mechanical

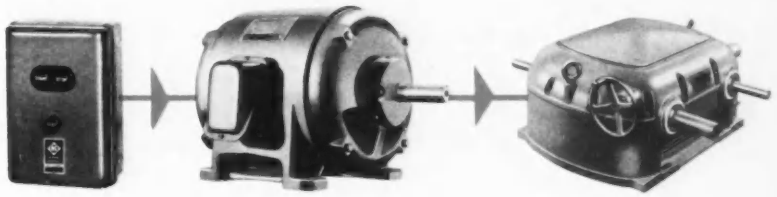
Speed may be changed while machine is in motion, particularly good for machines requiring fine adjustment while operating. Double range of adjustment may be obtained by using two sheaves. Horsepower range — 1½ to 300. Speed adjustment range — 9 to 28 percent.



Reduced voltage starter | Squirrel cage motor | *Vari-Pitch* motion control drive

Mechanical

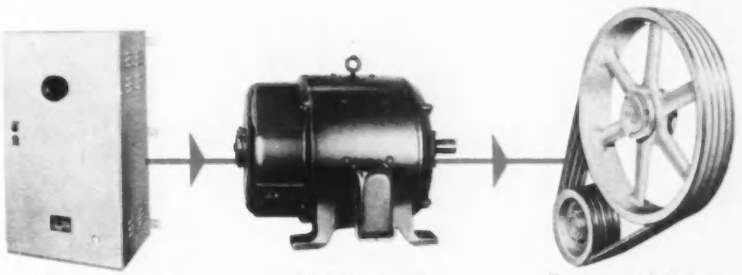
Enclosed unit with *Vari-Pitch* sheaves for speed control. For machines where extremely wide speed control is required. May be manually or remotely controlled. Motor may be mounted on speed changer housing for compact installation. Horsepower range — 1½ to 75. Speed adjustment range — 3¾ to 1.



Across-the-line starter | Squirrel cage motor | *Vari-Pitch* speed changer

Electrical

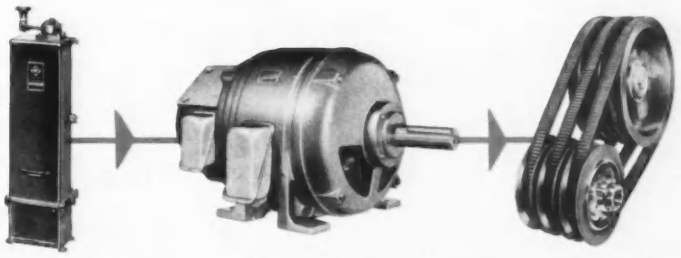
Speed is varied by means of various types of control. Available in shunt or compound wound for both constant and variable torque loads. Speed control may be stepped or stepless. Horsepower range—½ hp up. Speed adjustment range — zero to maximum speed. Maximum speed in smaller sizes, 3500 rpm.



Direct current control | Direct current motor | *Texrope* V-belt drive

Combination

For extremely wide range speed control, this combination drive combines the speed control range of the motor with that of the *Vari-Pitch* drive. Other combinations of electrical and mechanical variable speed can be worked out to fit the requirements of a particular design.



Wound rotor motor control | Wound rotor motor | *Vari-Pitch* wide range drive

ALLIS-CHALMERS

Nation Wide Service

YOUR CUSTOMERS will have no trouble getting competent service on your products when you use Allis-Chalmers motors, control and drives. There are nearly 100 Allis-Chalmers Certified Service Shops located in every industrial area in the country.

Allis-Chalmers Certified Service Shops are hand-picked independent units which have been chosen for their modern equipment, efficient methods, wide experience and business integrity. These Certified Service Shops assure your customers of factory-approved parts and service methods on Allis-Chalmers drive equipment. If you use special motors, the factory makes available to all Certified Service Shops the necessary information to assure a good service job.

A-3955

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

SEND THIS COUPON TODAY

Allis-Chalmers Manufacturing Company
Box 512
Milwaukee 1, Wisconsin

Please send me the literature for designers checked below.

Motors

- ☐ Handy Guide to Motor Selection 51B6052
- ☐ Squirrel Cage Motors 51B6210

Control

- ☐ Across-the-line Starters 14B7132
- ☐ Reduced-voltage Starters 14B7215

***Texrope* Drives**

- ☐ Handy Guide to *Texrope* Drives 20B6051
- ☐ *Vari-Pitch* Drive Engineering Data 20B7499

Name..... Title..... Company.....

Address..... City and State.....

U. S. Air Force crash trucks and rescue vehicles by American-LaFrance-Foamite Corp., Elmira, N. Y., use Revere Aluminum.

Aluminum Conductor Busway, light and economical, by Bull Dog Electric Products Co., Detroit, Mich., uses Revere Aluminum (EC Grade) Bar.

Industry Depends Upon The Versatility Of REVERE ALUMINUM

Revere meets the requirements of industry with a wide range of aluminum alloys in extruded shapes, coiled sheet, drawn tube, electrical bar and forgings. And industry knows the fine, uniform quality of Revere Aluminum. Each customer's requirements, based on their specific uses of Revere products, receives careful attention by Revere quality control.

For assistance in the efficient manufacture of products using aluminum, you are invited to utilize Revere's Technical Advisory Service.

REVERE ALUMINUM

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

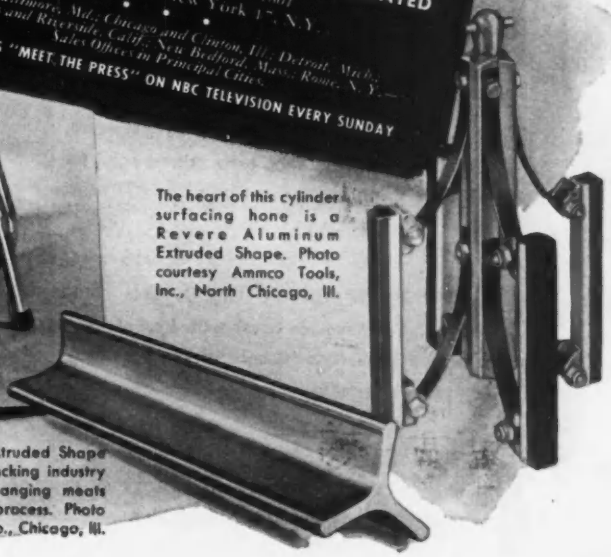
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

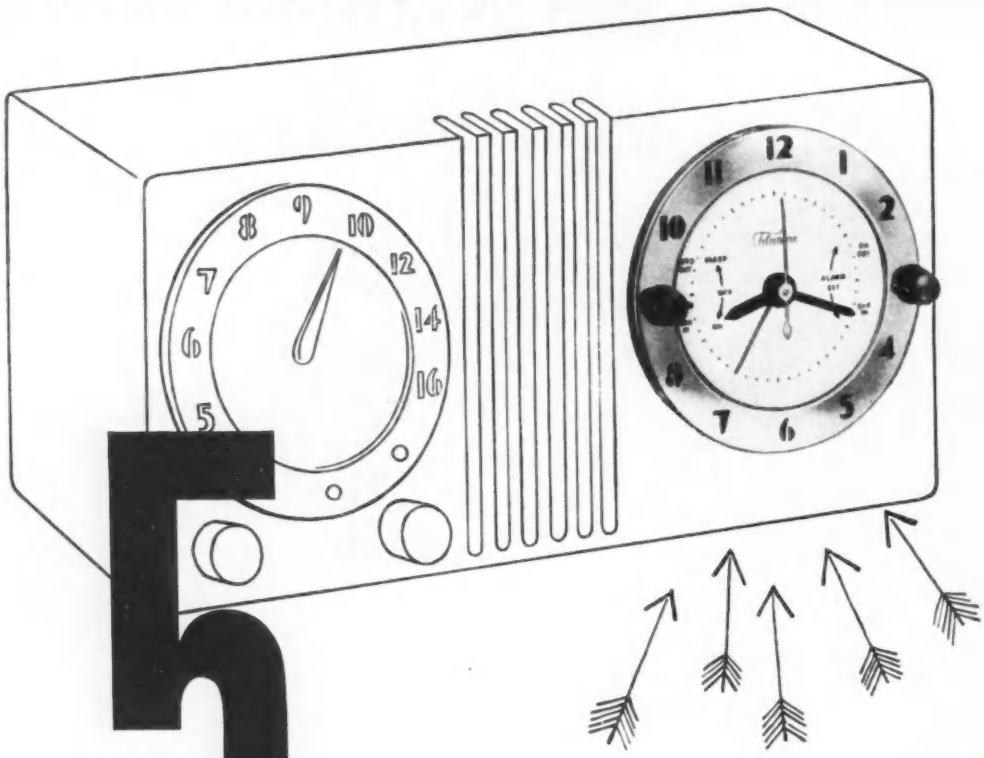
Many makers of indoor and outdoor chairs and furniture use Revere Aluminum Tube. This chair by Lawnlite Co., Miami, Florida.

The heart of this cylinder surfacing hone is a Revere Aluminum Extruded Shape. Photo courtesy Ammco Tools, Inc., North Chicago, Ill.



A Revere Aluminum Extruded Shape is used by the meat packing industry as smoke-sticks for hanging meats during the smoking process. Photo courtesy The Globe Co., Chicago, Ill.

in **TELECHRON TIMERS** only . . .



5 FEATURES TO HELP YOU DESIGN YOUR NEW CLOCK-RADIO

1 TWO KNOBS do the work formerly done by three. The new Telechron Timer, model C-78, means unmatched simplicity in clock-radio operation. One knob for alarm . . . the other for radio.

2 SIGNAL ALARM. It's a must for heavy sleepers. And it's a sales-boosting extra talking point for your clock-radio. In the clock-radio field only Telechron Timers have the signal alarm.

3 RADIO ALARM "ON" SWITCH. Contacts rated at 15 A. at 115v. a-c. Adequate to carry the load of a variety of electrical appliances through an auxiliary outlet on your clock-radio.

4 DEPENDABLE SLEEP SWITCH. Simple design—friction geared to clock movement—insures accuracy, dependability, and sturdy endurance even with rough handling.

5 FREEDOM OF STYLING. Two-knob control and separate alarm hand mean greater freedom for your styling people. Telechron Timers are available with round or square face . . . any color dial, hands or bezel.

Sales-Boosting Extra Benefit

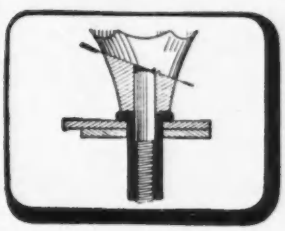
You are free to display the Telechron trade-mark and the Telechron Seal of Accuracy on your clock-radio. Ask for full information. Telechron Department, General Electric Company, 12 Homer Ave., Ashland, Massachusetts.

Telechron®
MARK OF TIMING LEADERSHIP

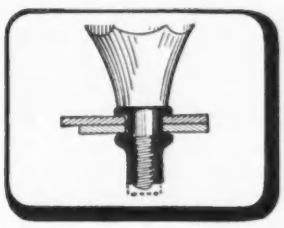
One B. F. Goodrich Rivnut does two fastening jobs, cuts assembly cost!

Rivnuts provide at least 6 clean threads in one simple operation!

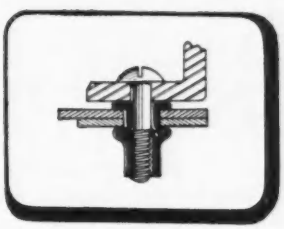
1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2. Rivnut is inserted—head firmly against work—tool at right angles to work.

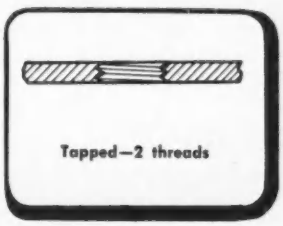


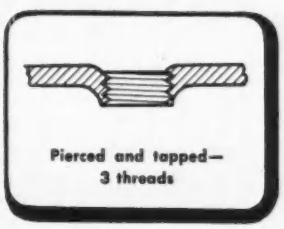
3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

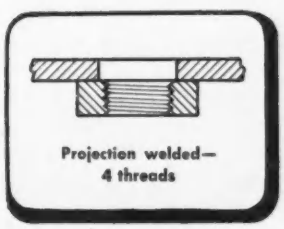


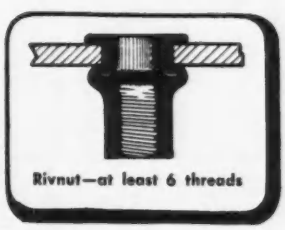
4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.

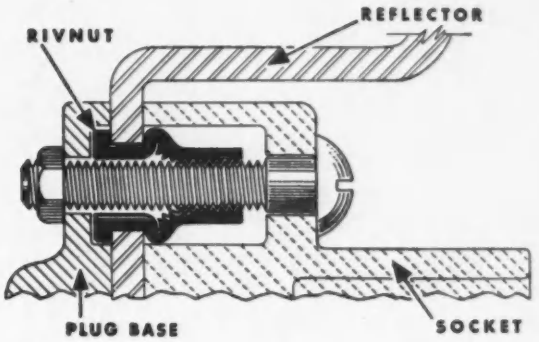
Compare these 4 methods of putting screw threads in thin sheet metal











B. F. GOODRICH RIVNUTS cut assembly time and costs since they provide a firm, accurate nut plate in one quick operation. Welding, tapping are eliminated. Rivnuts can be installed from *one side* and can take an attachment bolt from either end.

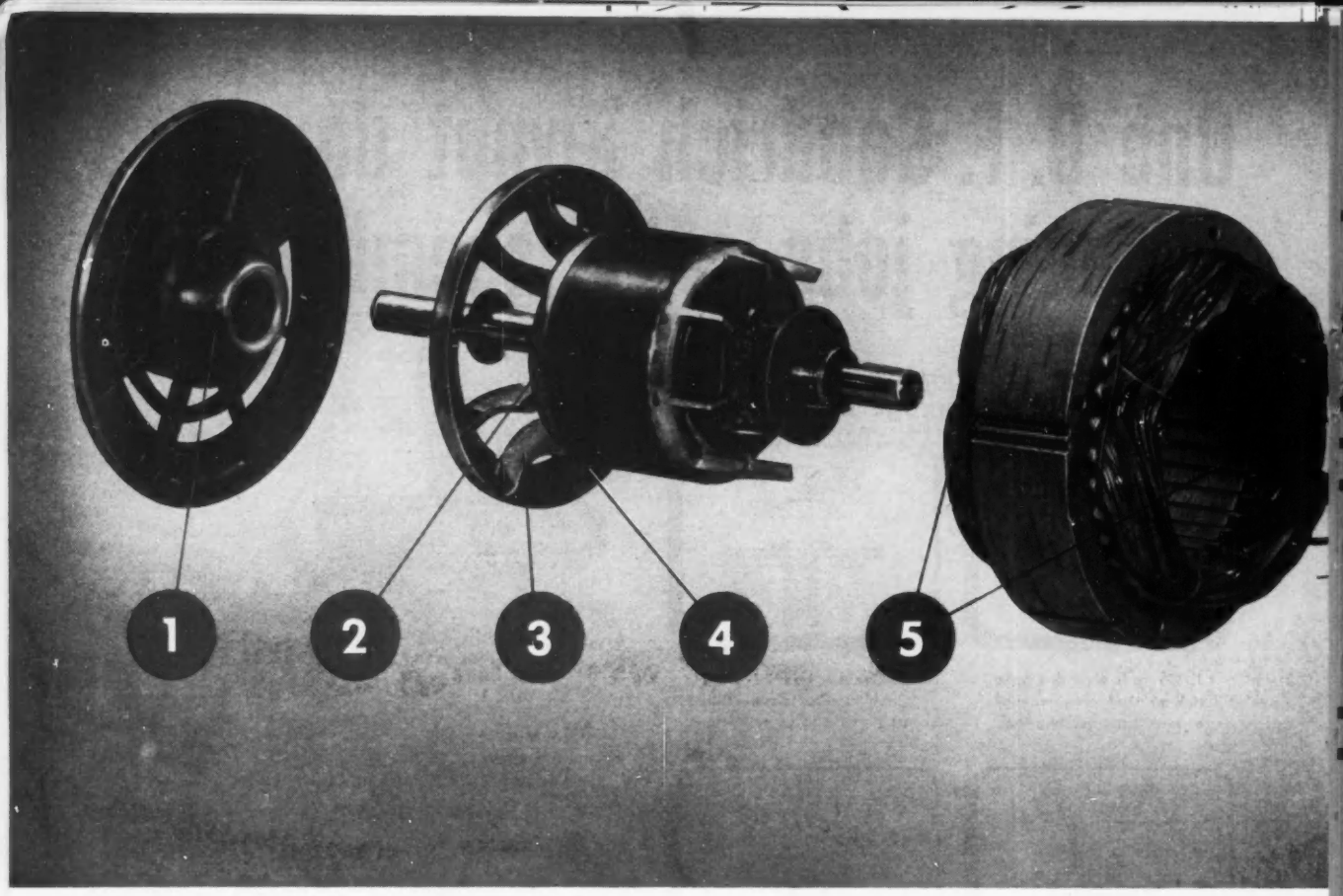
In the application above (assembling spotlights) Rivnuts completely eliminated use of threaded studs which required welding in close quarters. They also eliminated a separate piercing and tapping operation and made it possible to attach nuts from the outside of the assembly instead of the inside. Rivnuts provided further cost savings since they could be attached *after* enameling without marring the finish of the unit.

Whatever your fastening problem, there's probably a B. F. Goodrich Rivnut that can cut both assembly time and costs. Get complete information and engineering help by calling in a B. F. Goodrich Rivnut engineer. *The B. F. Goodrich Company, Department PE-23, Akron, Ohio.*

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-23, Akron, Ohio.

B.F.Goodrich RIVNUT *The only one-piece blind rivet with threads*



1. VERSATILE!—All-angle bearing and lubrication system permits motor to operate in any position.

2. SMOOTH RUNNING!—Precise rotor balancing and concentricity of rabbets and bearings.

3. EFFICIENT!—New electrical design, ventilation give top performance in least space.

4. QUIET!—Advanced magnetic design and unitized rotor-fan casting provide quiet operation.

5. LONG-LIFE!—*ALL* synthetic insulation resists moisture, corrosion and electrical breakdown.

Ten good reasons for using

Above you see ten good, basic reasons for using the all-new G-E "form G" motor—right now! And at your right are four big "plus" reasons perhaps even more important to you.

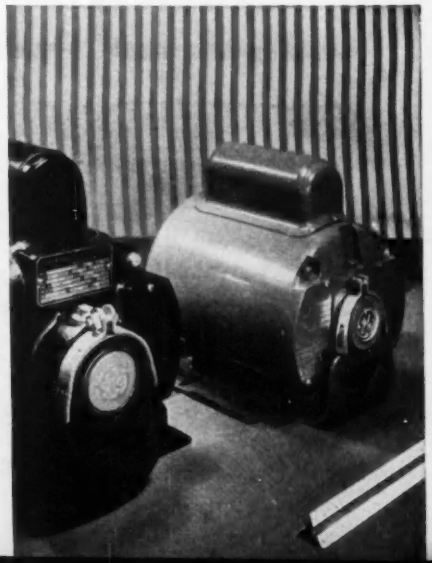
Completely different . . . completely *functional* . . . this general-purpose motor gives you full NEMA performance plus up to *50% less weight, 40% less bulk—rating for rating!*

You get efficiency, sturdiness, extra long life . . . *plus quiet, all-angle operation in every rating!*

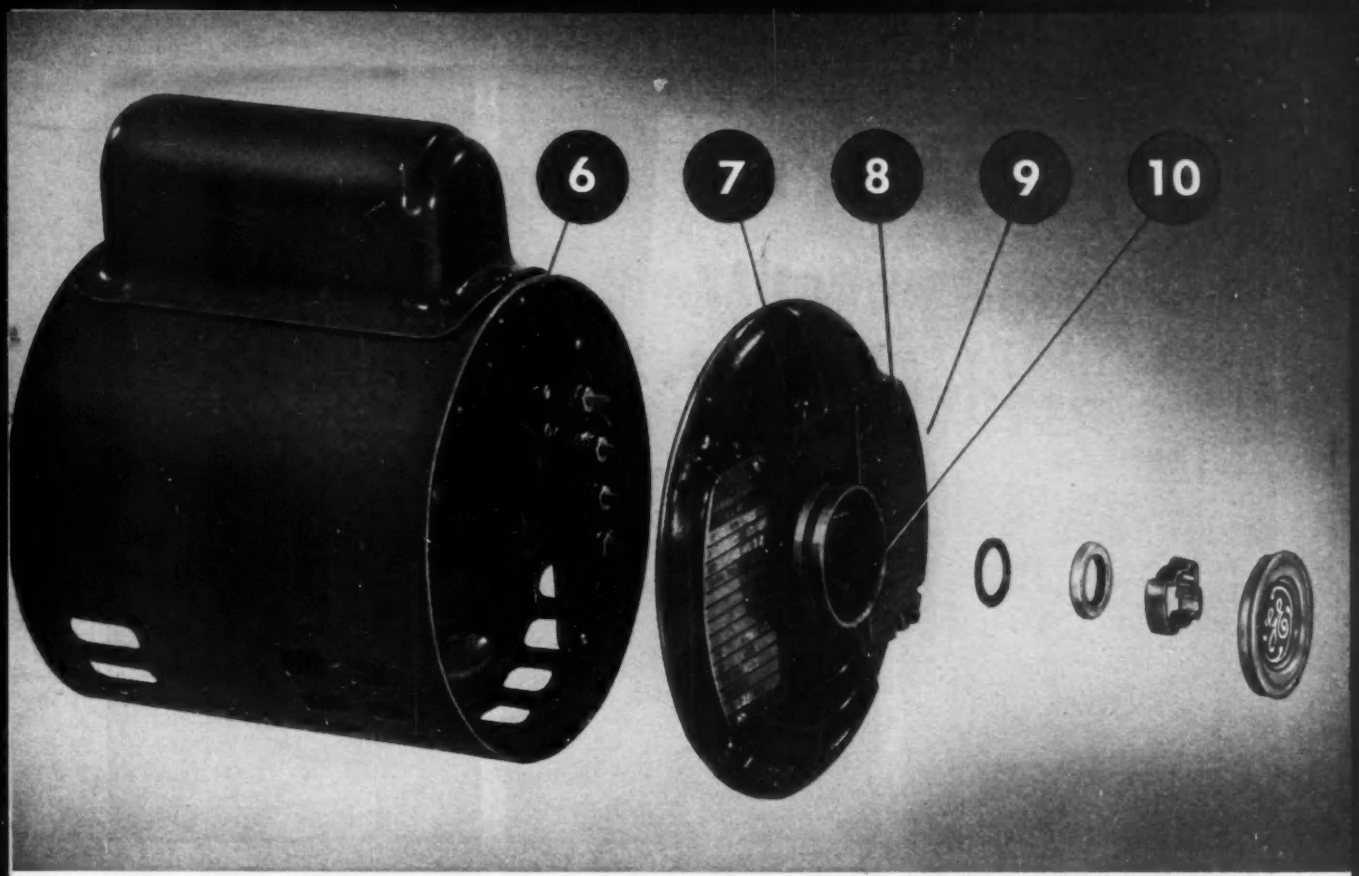
Now you can improve your product, speed assembly time, cut your handling and shipping costs.

Want more good reasons for using this new motor? Contact your nearest G-E Apparatus Sales Office or write for bulletin GEA-5567. Address Section 700-121, General Electric Co., Schenectady 5, N. Y.

SMALLER . . .



GENERAL ELECTRIC



6. STURDY!—Another G-E innovation: shell is expansion-fitted to stator: a strong *unit* assembly.

7. LESS MAINTENANCE! Spacious oil reservoirs —no lubrication required on some applications.

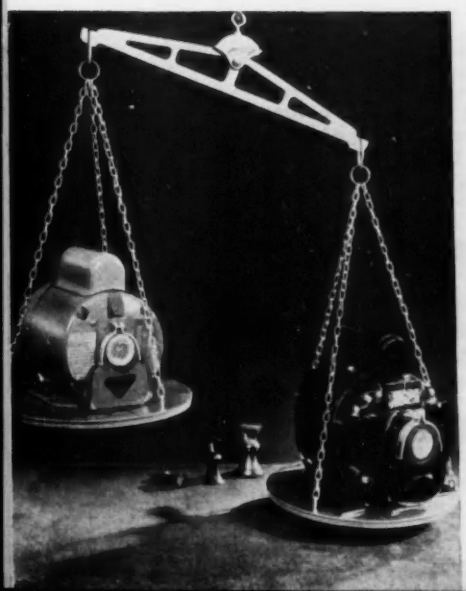
8. CONVENIENT!— Roomy terminal box— cover has connection and lubrication instructions.

9. RIGID!—This motor has strong, lightweight aluminum end shields especially rib-reinforced.

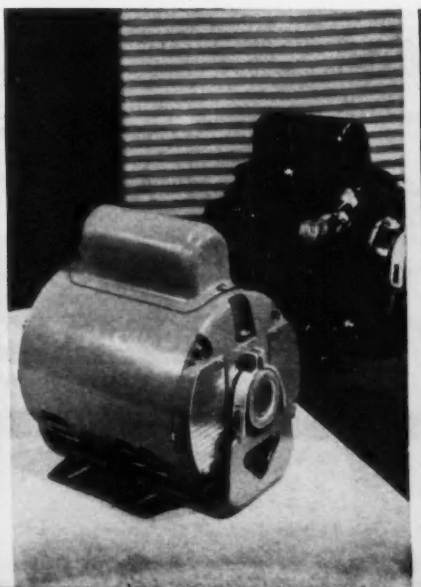
10. FLEXIBLE—Cradle bases—*solid* or resilient —facilitate easy mounting in any position.

the all-new G-E Fhp motor!

LIGHTER . . .

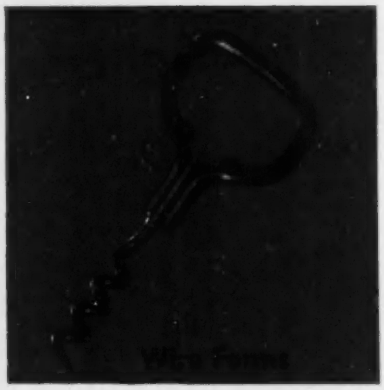


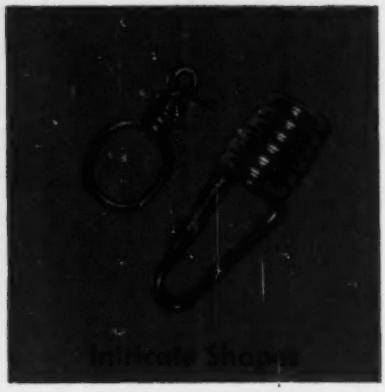
BETTER LOOKING . . .

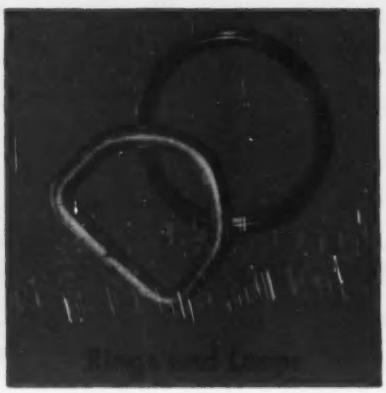


MORE VERSATILE!

Call on us for large quantity production of...







and precision deep-drawing... ...

Eastern Tool & Mfg. Co. has complete production facilities for the automatic manufacture of a wide variety of sizes and designs of the items illustrated above. Our plating department is fully equipped and experienced in large volume metal finishing operations.

Our deep-drawing facilities are now devoted exclusively to the manufacture of ordnance components with up to .001" wall tolerance. We welcome inquiries from interested manufacturers.

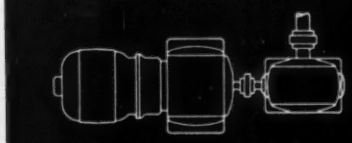
Send for your copy of the new 24 page Eastern Tool & Mfg. Co. descriptive booklet No. 100, the story of our background and services.

Eastern Tool & Mfg. Co.

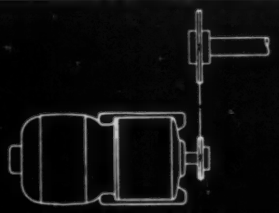
Belleville 9, New Jersey

Wire Forming • Metal Stamping • Deep-drawing

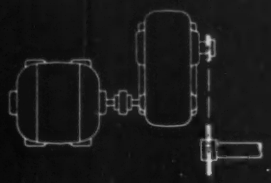
Is your speed reduction problem in this picture?



High-ratio reduction and right-angle takeoff

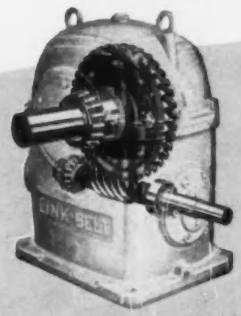


Restricted Space for mounting



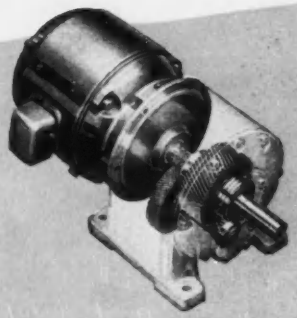
High hp with parallel takeoff

If it is, LINK-BELT has the right reducer for your requirements



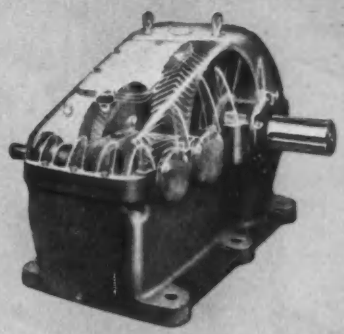
Worm Gear Drive

Reduction ratios: 3.1:1 to 8000:1. Torque: 1400 to 123,000 in. lbs. Output shaft rpm: 0.22 to 564. Drawing shows motorized P.I.V. variable speed and worm gear drives direct-coupled.



Gearmotor

Reduction ratios: 6.2:1 to 292:1. Hp range: 1 to 30. Output shaft rpm: 6 to 280. Drawing at top of page shows gearmotor with roller chain drive.



Herringbone Gear Drive

Reduction ratios: 2.84:1 to 318:1. Hp range: ½ to 1000. Output shaft rpm: 2 to 600. Drawing at top of page shows motor with herringbone gear drive and roller chain drive.

Yes, LINK-BELT builds all 3

HELICAL, Herringbone or Worm gear drive — Link-Belt builds them all. And all are made in the widest range of hp ratings and reduction ratios. Truly a specific drive for every reduction problem.

All of this enables the Link-Belt power transmission engineer to recommend the *one* drive best suited to your requirements. And you can be equally sure that every Link-Belt drive is precision engineered for quiet, economical, long-life service.

Call the Link-Belt office near you for engineering information on any or all of these enclosed gear drives. Send for catalogs.

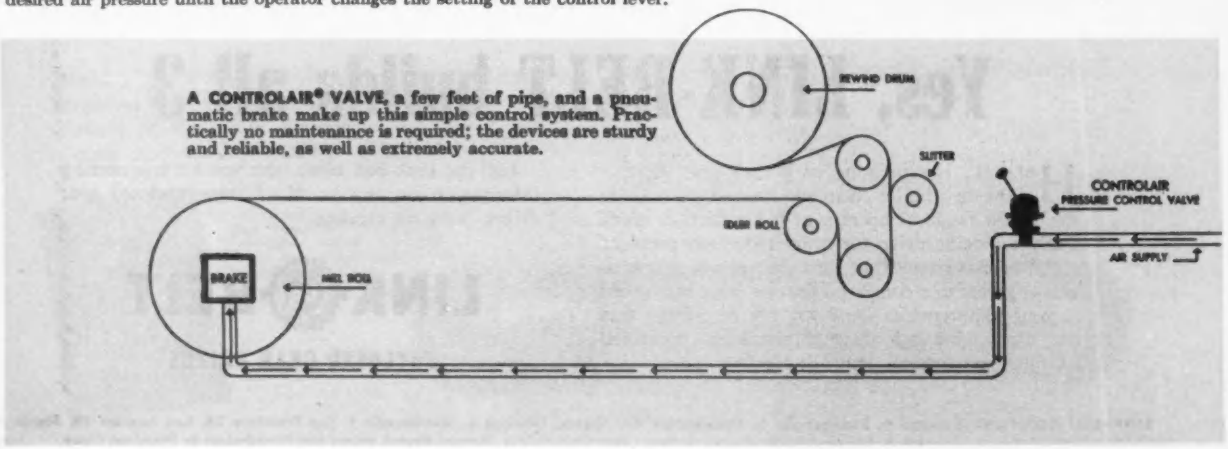
LINK-BELT

ENCLOSED GEAR DRIVES

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices, Factory Branch Stores and Distributors in Principal Cities. 12,681

Let AIR do the work

COMPRESSED AIR is used to control paper tension in this Camachine paper slitter installed at Miro Container Co., Inc. A Westinghouse Controlair® pneumatic valve regulates the air pressure. Once set, this valve automatically maintains the desired air pressure until the operator changes the setting of the control lever.

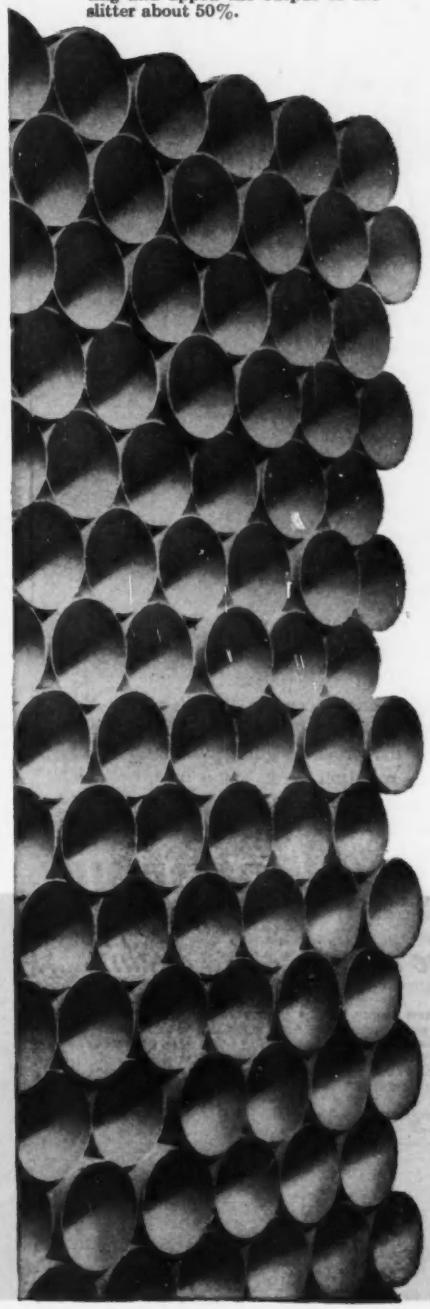


A CONTROLAIR® VALVE, a few feet of pipe, and a pneumatic brake make up this simple control system. Practically no maintenance is required; the devices are sturdy and reliable, as well as extremely accurate.

Westinghouse pneumatic control

boosts output of paper slitter 50%!

HERE'S THE PRODUCT—paper food containers that are wound from paper that is slit on the Camachine. Precise penumatic control materially reduced torn paper during slitting and upped the output of the slitter about 50%.



"*Don't take it away!* This Controlair® valve really works smooth!" That's what the man said who runs the Camachine paper slitter at the Brooklyn plant of Miro Container Co., Inc. The new Westinghouse air-pressure control valve was paying off — in more production, lower costs, and smoother operation.

Cameron Machine Co. of Brooklyn, N. Y., makes the Camachine. They control paper tension by regulating the speed of the input paper roll with a pneumatic braking system. The air pressure supplied to the brake diaphragm must be controlled precisely to prevent backlash and interleaving of the paper; but the valve they had been using was inaccurate. Paper was tearing and interleaving, wasting paper and delaying production.

The Westinghouse Controlair® valve has everything Cameron engineers had been looking for. It's rugged and simple. It operates easily. And it's *accurate* . . . automatically maintains a selected air pressure against line leakage.

Since this valve was installed at Miro Container Co., paper loss has dropped about 10%. With fewer production delays, about 50% more paper can be slit per day.

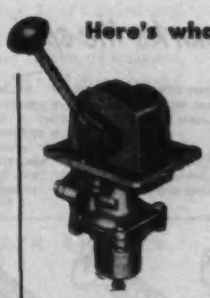
PUT AIR TO WORK ON *YOUR* EQUIPMENT

We can give you expert advice on the most profitable way to use air. And we can offer you a complete line of proven pneumatic devices—everything from air compressors to valves and actuators and including a complete *new* line of cushioned pneumatic cylinders, all made by Westinghouse Air Brake Co. Write for information.

Westinghouse Air Brake COMPANY

INDUSTRIAL PRODUCTS DIVISION WILMERDING, PENNA.

Factory Branch: Emeryville, Calif.
In Canada: Canadian Westinghouse Co. Ltd., Hamilton, Ontario



Here's what you can do with the CONTROLAIR® pneumatic valve

Use this Westinghouse Controlair® valve wherever you want a variable, controlled air pressure below 100 psi. It has been used to operate pneumatic clutches, brakes, cylinders, and actuators on diesel engines, hoists, wire-drawing rolls, chemical flow valves, clamping devices, and other equipment. You can operate this valve by hand, foot, or cam.

Other pneumatic devices made by Westinghouse Air Brake Co. include: flow, relay, and check valves, chokes, cocks, single- and double-acting cylinders, actuators, line filters, and air compressors. You can get a complete pneumatic system from Westinghouse Air Brake Co.

What's Screwy? by Phillips

"Oh, he never bothers to turn it on. He's just fascinated by the beauty of those Phillips Cross-Recessed-Head Screws."

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

BEAUTY is only one of many reasons why Phillips Screws help you build a better product. These screws set up tighter, resist vibration. They are distinctively designed to give maximum strength of head, maximum driver strength. What's more, they cut driving time up to 50%, eliminate driver skids and split screw heads. Whether you use Phillips Wood, Machine, Tapping Screws or "Sems", you save time, work, money.

PHILLIPS *Cross-Recessed-Head* SCREWS

X marks the spot... the mark of extra quality

AMERICAN SCREW COMPANY • ATLANTIC SCREW WORKS, INC. • THE BLAKE & JOHNSON CO.
CENTRAL SCREW COMPANY • CONTINENTAL SCREW COMPANY • THE EAGLE LOCK COMPANY
ELCO TOOL AND SCREW CORPORATION • GREAT LAKES SCREW CORPORATION • THE H. M. HARPER CO.
THE LAMSON & SESSIONS COMPANY • NATIONAL LOCK COMPANY
THE NATIONAL SCREW & MANUFACTURING CO. • PARKER-KALON CORPORATION
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF DIV. OF ILLINOIS TOOL WORKS • THE SOUTHINGTON HDWE. MFG. COMPANY
STERLING BOLT COMPANY • STRONGHOLD SCREW PRODUCTS, INC. • WALES-BEECH CORP.

TODAY'S... AND THE FUTURE'S... FINEST FASTENER

TENSION LINKAGE

WHAT'S THAT?

Some designers have been asking us what we mean by the term "tension linkage." We use it to describe any chain application in which the linear movement of the chain is not continuous in direction. The predominant feature of a tension linkage application is that the chain need not be formed as an endless chain belt.

There is a wide variety of possible tension linkage applications.

here's one example

Suspension of the load on a chain hoist. The load is lifted or lowered by the rotation of the sprocket. One end of the chain is permanently anchored as indicated. The free end is fastened to the object to be lifted or lowered. The sprocket is driven by hand power or motor power through gearing. The slack side of the chain usually hangs freely, thus providing 180° wrap on the sprocket.

here's another one

Reposition of a shaft that has been rotated through a limited angle. The shaft is turned clockwise (as shown in the illustration) during some operation of the associated equipment. The resulting compression of the spring provides the energy necessary to return the shaft to its original position. In many cases of this type, operation is frequent and high shock loads are encountered, so *chain* is the answer.

Our Bulletin No. 51-10 contains complete details on why Baldwin-Rex® Roller Chains, Leaf Chains and Block Chains are ideal for tension linkages. It also contains application examples and tables of weights, strengths and dimensions. Use the coupon to send for it today.

BALDWIN-REX

ROLLER CHAINS

A PRODUCT OF

Chain Belt COMPANY

OF MILWAUKEE

Chain Belt Company 52-401T
321 Plainfield Street
Springfield 2, Mass.

Gentlemen:
Please send me Bulletin 51-10.

Name.....

Company.....

Address.....

City.....*State*.....

GAIN valuable PARKER

Add durability to paint and control corrosion with BONDERITE

A dozen things you use every day are Bonderite-protected. Bonderite, under the paint on automobiles, appliances, office and industrial equipment, guards against rust and corrosion, anchors the paint, adds years to the appearance and service life of the finish.

Bonderite, applied by spray or immersion, converts the surface of metal to a nonmetallic phosphate coating. It is adaptable to varying requirements, operates with simplicity and dependability. It is low-cost, adds greatly to paint performance.

Add maximum corrosion resistance with PARCO COMPOUND

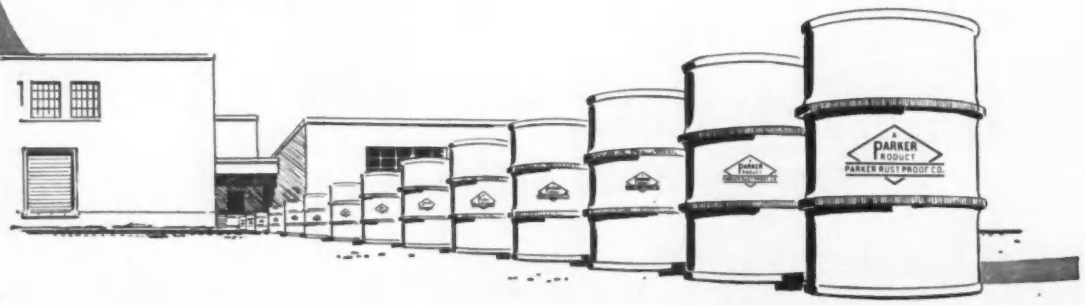
Iron and steel gain most effective protection against rust when treated with Parco Compound. Creates a nonmetallic crystalline phosphate coating over all surfaces of the product treated. Size and shape of product makes no difference—anything which can be immersed in the tank can be treated. Tools, springs, brackets, hardware, ornamental iron, plates, nuts, bolts, and nails are among the hundreds of items on which Parco Compound is used. It's industry's standard rust-resistant product.

Greater efficiency, economy in cold forming of metals with BONDERITE and BONDERLUBE

This is the combination of Parker Products which have put many "problem draws" into production routine. The nonmetallic Bonderite coating—used for years in tube mills for its ability to hold lubricants, minimize galling, lengthen tool and die life—joins with scientifically compounded Bonderlubes. This combination allows deeper draws, more severe extrusions. Saves time, money and materials. Used in manufacture of shell cases, shafts, gears, etc.

Get jet black corrosion resistant coating with PARCO BLACK

Jet black color and effective corrosion resistance from a single bath! Parco Black is not a dye, but chemically converts the surface of iron and steel to produce the protective coating. It is safe, simple, easily controlled. Products to be treated are immersed in a low temperature (about 180°) bath for a few minutes. Corrosion resistance of Parco Black is as much as ten times that of conventional "blacks."



advantages for your products by using a metal surface treatment . . .

Get increased wearing quality on friction surfaces with PARCO LUBRITE

This Parker product creates a nonmetallic phosphate coating on friction parts and bearing surfaces. Its action is to prevent metal-to-metal contact, hold lubricant, prevent galling and scratching. Smooth, easy break-in is assured, and longer subsequent service life is promoted.

Used with great success on gears, shafts, pistons, piston rings, valves, cylinder linings, etc.

Protect structural steel, large fabrications with "Bonderite-quality" PARCO PRIME 47

Now, steel structures and big fabrications can have the benefits of Bonderite-quality corrosion resistance and paint adhesion. Parco Prime 47 can be sprayed or brushed on, quickly conditions the metal to take and hold prime and finish coats. Recommended for bridges, tanks, truck and trailer bodies, structural steel, freight cars.

Clean your production with a cleansing and conditioning PARCO CLEANER

The Parker line includes alkali, acid and emulsion cleaners formulated not only to remove grease and soil but to condition the work for the next step in finishing as well. There's a Parco Cleaner to meet your conditions of soil, production requirements and finishing operations.

Use PARCOLAC to stain, wax, or oil-finish parts

This group of products is made up of various finishes for use after Parco Compound. Includes wax base finishes, stains, and rust preventive oils suitable for application by dip, spray or centrifuge. Can meet fast or slow drying requirements. Parcolacs add to appearance and performance qualities of articles treated.

FIRST SINCE 1915

Parker

RUST PROOF COMPANY

**Bonderite, Bonderlube, Parco Compound, Parco Lubrite—Reg. U.S. Pat. Off.*

Send for **FREE** Technical Bulletins

Please send me information on products checked:

- ☐ Bonderite
- ☐ Bonderite and Bonderlube
- ☐ Parco Lubrite
- ☐ Parco Compound
- ☐ Parco Black
- ☐ Parco Prime 47
- ☐ Parcolacs
- ☐ Parco Cleaners

PARKER RUST PROOF COMPANY
2179 E. Milwaukee, Detroit 11, Michigan

NAME_____

FIRM_____

ADDRESS_____

Sure cure for the "shakes"

UNDER the terrific vibration of aircraft engines, screws and nuts have a tendency to become loose. That's why Army, Navy and Air Corps specifications call for safety wiring on engine mountings, instruments, gun sights, magnetos . . . *every* place on a plane where a screw or nut might shake loose.

By simply drawing the lock wire through a small hole in each nut or screw, and then twisting tightly with pliers, a positive sure cure for the "shakes" is provided.

Wire for this important function must be highly resistant to corrosion, tough enough to resist fracturing under the heat and vibration of aircraft engines, and soft enough to twist with pliers for quick assembly and replacement of parts. Here at National-Standard we've developed a type of slow-annealed stainless steel wire to fully meet these exacting requirements. And we're drawing millions of feet of this wire, not only for aircraft but also for many other automotive applications.

Developing special wire for special purposes has been an important part of National-Standard's business for more than 45 years. Perhaps our unique engineering and manufacturing facilities can help you with your wire and wire fabricating problems.

NS
NATIONAL-STANDARD
Company
NILES, MICHIGAN

DIVISIONS OF NATIONAL-STANDARD CO.

ATHENIA STEEL	*Clifton, N. J.*	**Flat, High Carbon, Cold Rolled Spring Steel**
NATIONAL-STANDARD	*Niles, Mich.*	**Tire Wire, Stainless, Fabricated Braids and Tape**
REYNOLDS WIRE	*Dixon, Illinois*	**Industrial Wire Cloth**
WAGNER LITHO MACHINERY	*Jersey City, N. J.*	**Metal Decorating Equipment**
WORCESTER WIRE WORKS	*Worcester, Mass.*	**Round and Shaped Steel Wire, Small Sizes**

short cuts to savings for you!

Custom-made

SYLPHON *STAINLESS STEEL* BELLOWS ASSEMBLIES

NO MATTER how "tricky" a bellows assembly you may require, we can make it for you—save you time and money, too.

You get the advantages of trained personnel—specialists in this highly specialized field. They're backed by half-a-century of experience in developing and producing bellows assemblies of all kinds.

You get service that saves you time. We take over all production problems and worries—see that you get bellows assemblies made *exactly* to your specifications, *on schedule.*

If you use, or plan to use, stainless steel (or other metal) bellows assemblies—for thermostatic devices, pressure controls, hydraulic mechanisms, recording instruments, valves or other applications—we can show you short cuts to savings. Write either Fulton Sylphon Division or Bridgeport Thermostat Division. Ask for idea-stimulating catalog CP-1200.

TEMPERATURE CONTROLS

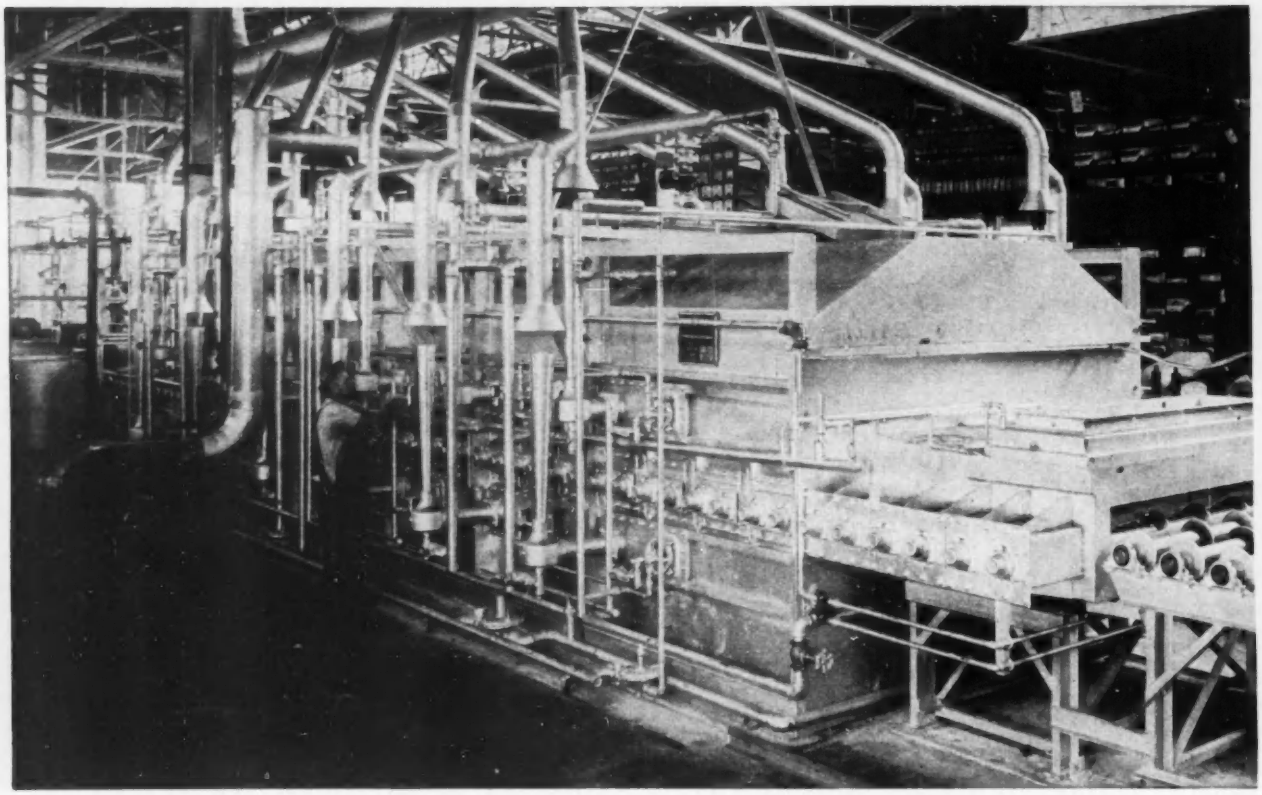
FULTON SYLPHON DIVISION Knoxville 4, Tenn.

Robertshaw-Fulton CONTROLS COMPANY

BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT DIVISION Bridgeport 1, Conn.

LINK-BELT ball and
keep company with America's

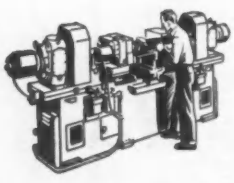


YOU can always count on top performance when you specify Link-Belt precision bearings. For Link-Belt's Sealed-Housing feature assures longer bearing life plus extended lubricating schedules. And Link-Belt alone offers this vital feature in *both* ball and roller models.

With this exclusive advantage, all moving surfaces are completely enclosed and lubricated from a large, common reservoir. Grease stays in, dirt stays out . . . and wear is minimized even under grueling operating conditions.

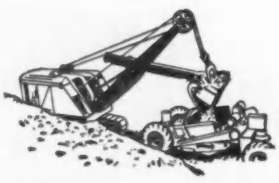
Link-Belt's experienced engineers will be glad to help you in your bearing application problems . . . with no obligation, of course. Or you may get full information from Data Book 2550.

LINK-BELT ball and roller bearings

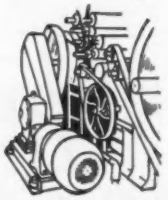


Metal Working Machinery

Farm Machinery

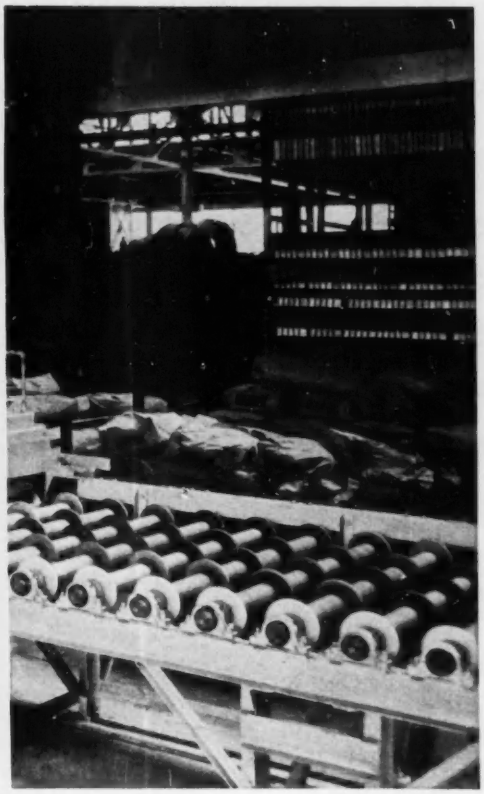


Construction Equipment



Textile Machines

roller bearings
hardest-working machines



Automotive parts are annealed by one of the big auto-makers in this continuous roller hearth radiant tube-fired furnace built by Surface Combustion Corp., Toledo, Ohio. As on many of their other furnaces, Link-Belt ball and roller bearing pillow blocks and flanged blocks are used to withstand the demands of high temperatures and continuous operation.

Universally aligning. Capacity for radial and thrust loads.
Wide inner ring distributes load over large shaft area.
Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Spring-locking collar with set-screw clamps bearing firmly on shaft.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring locking collar.
Sturdy, compact cast housing requires minimum support space, can be positioned on the side of a machine.

Cutaway of Series 200 Ball Bearing Flanged Block — part of Link-Belt's line of Pillow Blocks, Flanged, Flanged Cartridge, Cartridge, Hanger, Take-up Blocks and unmounted Bearings.

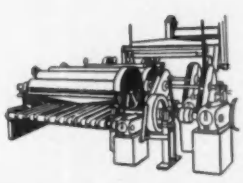
LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Plants: Indianapolis, Chicago, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

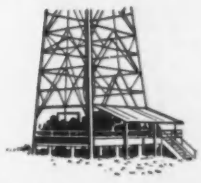
13,098

smooth the path of power for all industry

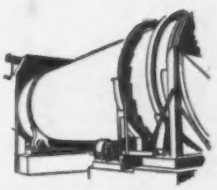


Pulp & Paper Machinery

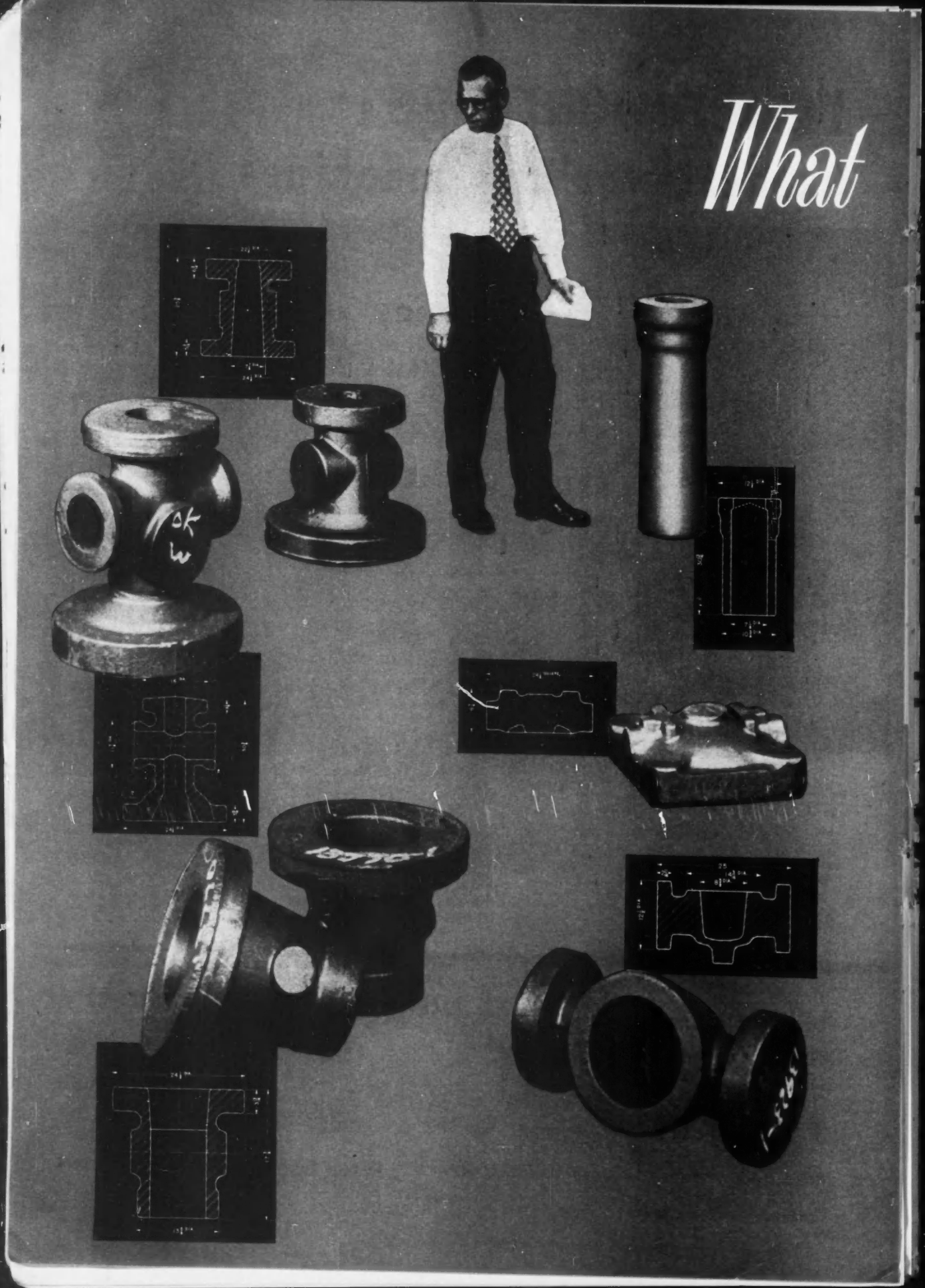
Materials Handling Equipment



Oil Field Equipment

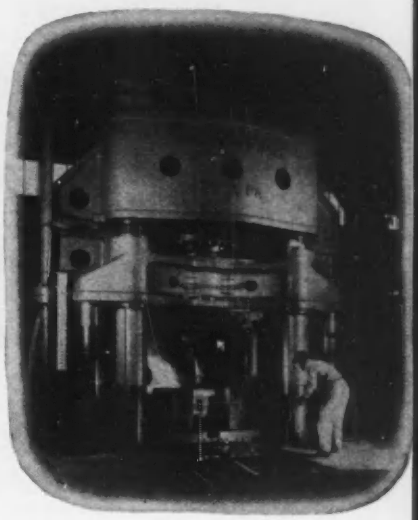


Processing Equipment


What

shape is your business in?

CAMERON PRESS - FORGINGS ARE NOW AVAILABLE TO HELP IMPROVE YOUR PRODUCT AND TO SPEED UP PRODUCTION SCHEDULES



Because of the limitations of conventional forging machinery and methods, many product designs have, of necessity, incorporated steel castings where forged steel members could be used to great advantage.

The closed die method of press-forging developed by Cameron Iron Works has vastly expanded the limits of size and shape of forgings, thus extending the metallurgical and manufacturing advantages of forged steel to a wider range of product designs.

Numerous intricate patterns, weighing up to 2000 pounds, which have been considered impossible, or impractical, to forge from ferrous metals heretofore, are now being produced at Cameron.

Inquiries as to how Cameron press-forgings may be fitted into your product designs will be given prompt attention. Send us your drawings and specifications.

CAMERON IRON WORKS, INC.

FORGE AND ORDNANCE DIV.

P. O. BOX 1212 HOUSTON, TEXAS

NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this page

Sealing News & Tips

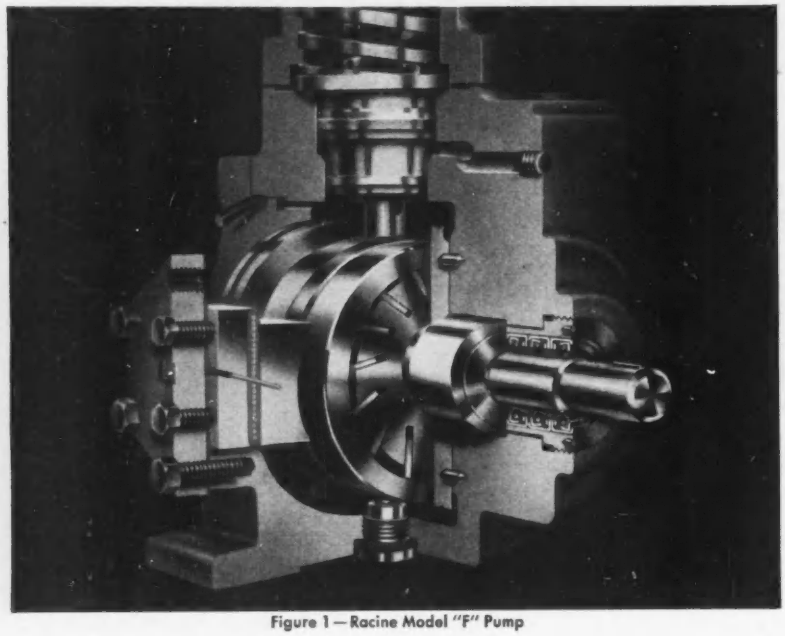


Figure 1 — Racine Model "F" Pump

Standard-design National Oil Seals, O-Rings give effective, low-cost sealing in Racine Pump

An unusual and highly economical solution to a two-way sealing problem is found in the shaft bearing assembly of Racine Hydraulic's Model "F" Pump.

Where the shaft enters the pump (Figure 1) it is necessary to prevent leakage of hydraulic oil (200 S.S.U. at 100°F) as well as intake of air, dust, and dirt. Pressure varies from slight suction to 25 p.s.i. Shaft speed averages 1,200 r.p.m. and the pump may be in continuous operation over long periods of time. External abrasive conditions are often very severe.

The unusual approach of Racine's engineers is to employ three single-lip National seals. All are modified National 50,000-S Syntech* seals—spring-tensioned units with precision-trimmed synthetic rubber sealing members inside a steel outer case. Two such seals are mounted with sealing lips inward to retain pressure and oil. The third seal is mounted outward and operates virtually "dry" as a dust excluder.*

On the faceplate assembly opposite the sealing point, Racine solves a static sealing problem economically with a commercial-grade O-Ring also supplied by National.

Racine's use of standard-design National seals not only expedites seal deliveries but saves tooling costs. Whether your application utilizes standard-design seals or requires special seal design, National Applications Engineers are at your service.

Figure 2 — National 50,000-S series Syntech (Modified)

Note: This application shows that National seals may be used under conditions more severe than intended. However, before exceeding seal performance specifications, discussion with the nearest National engineer is recommended.

*Trade Mark Registered

Dual-Lip Opposed Syntech Seal

National 70,000-S Syntech seals are used in numerous applications where fluids or lubricants must be separated within a housing. Sealing lips are of synthetic rubber, precision-trimmed to a "knife" edge for positive sealing, mounted in opposed position and spring-tensioned. They are capable of continuous operation with zero leakage at intermittent temperatures up to 300°F, speeds to 7,000 F.P.M. and run-out to .030 indicator reading.

External Expansion Leather Seals

National 80,000 series spring-tensioned leather seals are designed for applications where the shaft remains stationary, the bore rotates, and the centrifugal force would impair operation of a shaft-type seal. Use of this external design in such cases often simplifies machinery design and facilitates assembly.

National Shims, Shim Seals

National Shims and Shim Seals are available in a wide range of sizes and shapes and in all thicknesses from .002" upward. The uniform density of metals employed prevents compressing under severe pressure. National Shims are used by all leading vehicle, equipment, and machinery manufacturers. For complete information, request Catalog 93.

"Let Your Decision be Based on Precision"

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

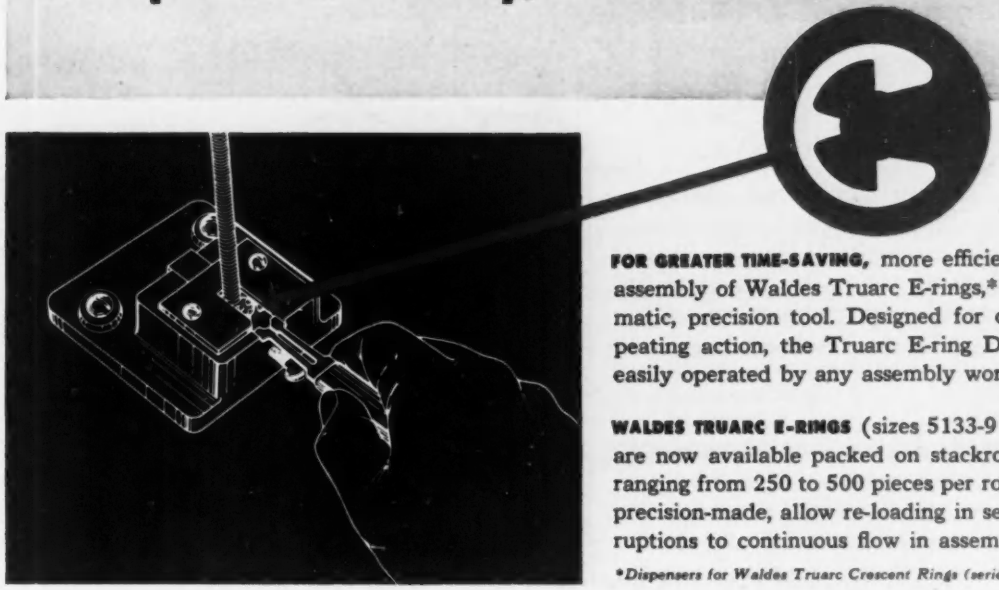
NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2582

CALL IN A NATIONAL APPLICATIONS ENGINEER

CHICAGO, ILL. . . . *Room 4113 Field Building, FRanklin 2-2847*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*

New Waldes Truarc E-Ring Dispenser* Speeds Assembly, Cuts Time and Costs



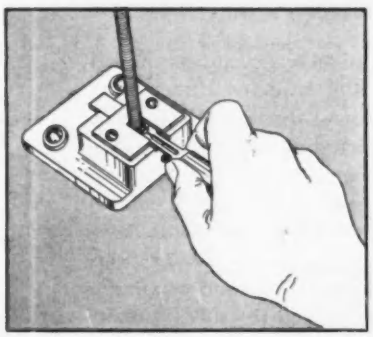
U. S. PAT. PENDING

FOR GREATER TIME-SAVING, more efficient handling and assembly of Waldes Truarc E-rings,* here is an automatic, precision tool. Designed for one-at-a-time repeating action, the Truarc E-ring Dispenser can be easily operated by any assembly worker.

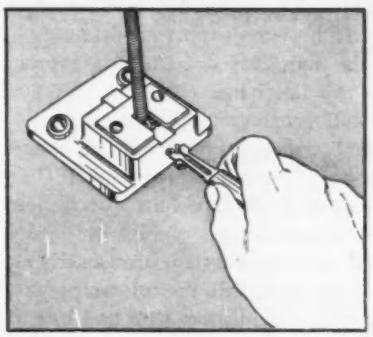
WALDES TRUARC E-RINGS (sizes 5133-9 to 50 inclusive) are now available packed on stackrods in quantities ranging from 250 to 500 pieces per rod. Stackrods are precision-made, allow re-loading in seconds. No interruptions to continuous flow in assembly.

**Dispensers for Waldes Truarc Crescent Rings (series 5103) also available.*

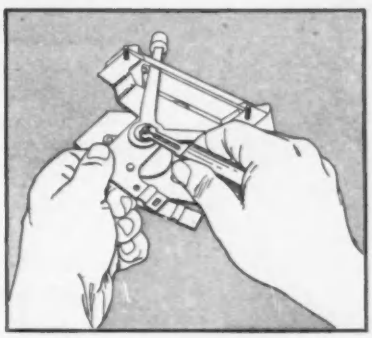
SIMPLE 1, 2, 3 ASSEMBLY OPERATION



■ Truarc applicator is pushed forward and grips a single E-ring.



■ Applicator withdrawn (new ring automatically feeds into place).



■ Ring is installed in groove on shaft. No waste time or motion.

WRITE, TODAY, FOR COMPLETE BROCHURE ON WALDES TRUARC E-RING DISPENSER ▶

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,282,947; 2,282,948; 2,416,832; 2,420,921; 2,428,341; 2,439,705; 2,441,846; 2,455,165; 2,493,390; 2,493,393; 2,497,802; 2,497,803; 2,691,308; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc.
47-16 Austel Place, L. I. C. 1, N. Y.

☐ Please send me the new Waldes Truarc E-ring Dispenser brochure.

☐ I am also interested in dispensers for Crescent Rings.

NAME_____

TITLE_____

COMPANY_____

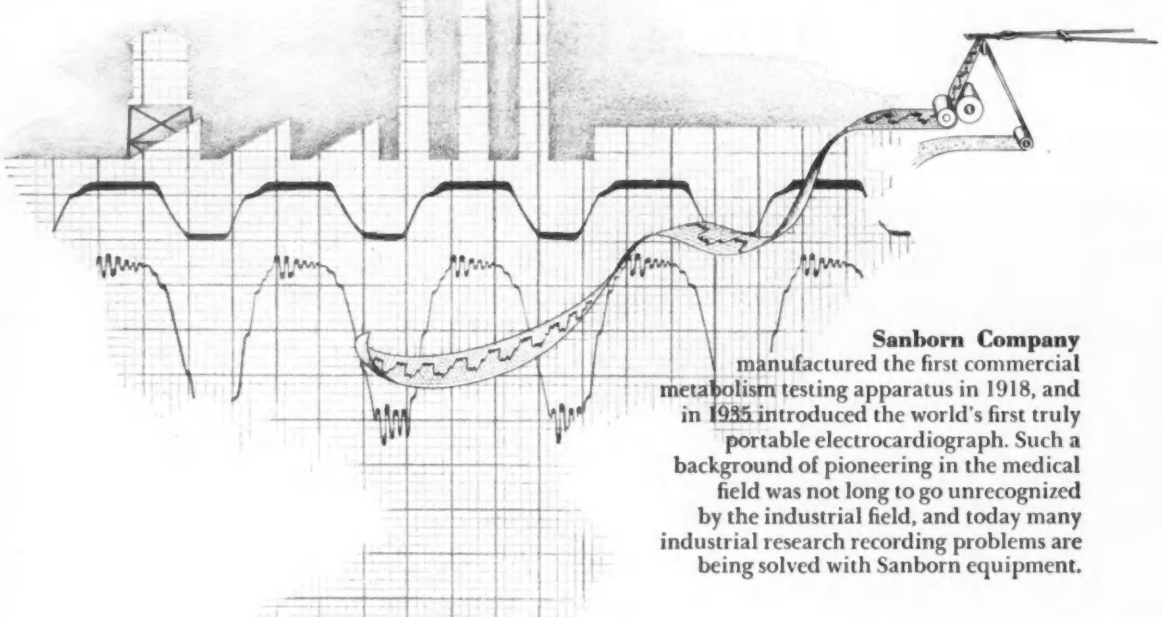
BUSINESS ADDRESS_____

CITY_____ ZONE____ STATE_____

PN-025

NO. SIX OF A SERIES

Pioneers in Precision

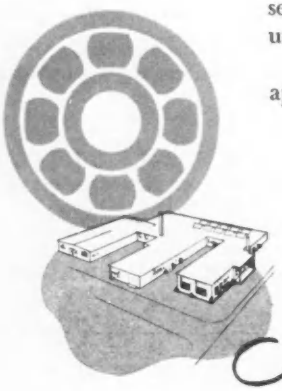


Sanborn Company manufactured the first commercial metabolism testing apparatus in 1918, and in 1935 introduced the world's first truly portable electrocardiograph. Such a background of pioneering in the medical field was not long to go unrecognized by the industrial field, and today many industrial research recording problems are being solved with Sanborn equipment.

Miniature Precision Bearings supply the same operational characteristics commonly associated with larger prototypes. Wherever design problems concerning unusual operating conditions are present . . . extreme temperature . . . shock . . . continuous high load capacity . . . limited space in instrument miniaturization projects . . . **MPB** ball bearings supply a vital need.

For more than 20 years, the originators and pioneer developers of ball bearings in this size range (1/10″ to 5/16″ o.d.), **MPB** supplies ultra quality miniature ball bearings to more than three thousand discriminating users. Exclusive and exacting production procedures – including full grinding, lapping, honing and/or burnishing to ABEC 5 tolerances or better – result in the type of quality which permits installation of these ball bearings in control and recording instruments of highest possible performance standards. **MPB** ball bearings are torque tested, ultrasonicly cleaned, supplied in specific clearances, and classified within the tolerances for prompt assembly and maximum service. More than a million **MPB** ball bearings have been installed in many unusual and distinctive devices.

The most extensive engineering knowledge in miniature ball bearing application is available to you. Also request Catalog and survey sheet PE2



Through extensive expansion, the production of these ultra quality bearings has been considerably increased. However; the continuing trend toward miniaturization, plus a constant demand for better quality bearings, has temporarily limited an immediate supply. Further expansion will soon enable us to serve you promptly.

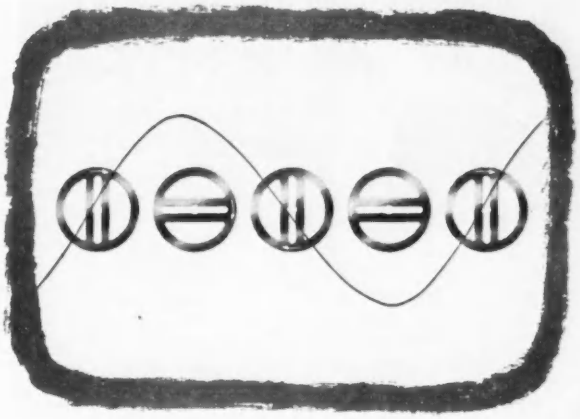
Miniature *precision* Bearings

Incorporated MPB Keene, New Hampshire

"Pioneer Precisionists to the World's foremost Instrument Manufacturers" { *save space weight friction*

EVER RUN INTO THESE **FALSE IDEAS**

ABOUT SYNCHRONOUS TIMING MOTORS?

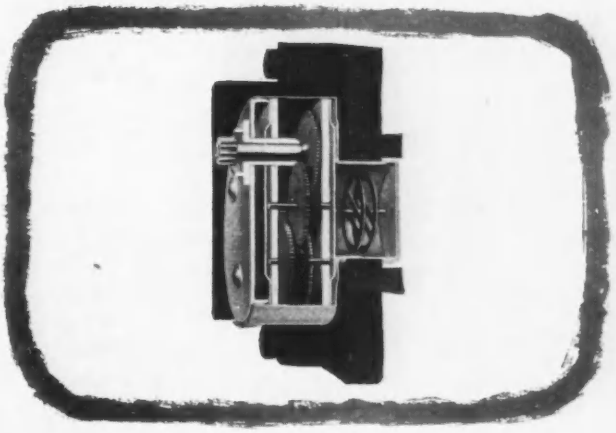


ALL SYNCHRONOUS TIMING MOTORS ARE FUNDAMENTALLY ALIKE

Not true. Telechron motors have the lightweight, low-inertia rotor that rotates once for every cycle of the alternating current. Thus Telechron motors are truly synchronous. They start instantly . . . reach full speed in less than a twentieth of a second . . . don't get out of "sync," even with severe fluctuations in line voltage.

ALL SYNCHRONOUS TIMING MOTORS GET NOISY AND FAIL AFTER A FEW YEARS

That hasn't been the experience of our customers. Of course, the rotor unit is entirely enclosed in Telechron motors . . . with a reservoir of special lubricant sealed in. Capillary action carries oil to all bearings. Dirt and dust can't get in. Many Telechron Synchronous Timing Motors are still giving dependable, accurate, quiet service after 20 years of continuous use.



IT'S EASY TO SPECIFY THE RIGHT MOTOR FOR A PARTICULAR JOB

Not unless you're an expert on timing problems. Because most of the time, only a timing motor specialist knows how to figure all the factors. And when you use Telechron Synchronous Timing Motors, you have the support of our experienced Application Engineering Service. We analyze the requirements of your application . . . and give an honest recommendation designed to assure you the longest motor life at the lowest unit cost.

WHAT'S YOUR APPLICATION?

Let us send you our complete catalog and application data sheet. Write Telechron Department, General Electric Company, 12 Homer Ave., Ashland, Mass.

Telechron®

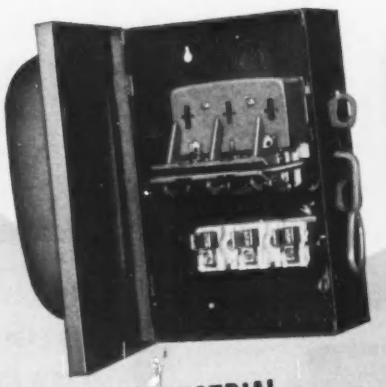
MARK OF TIMING LEADERSHIP

3 LINES OF SAFETY SWITCHES *for* 3 DIFFERENT MARKETS

one line can't do two or three jobs without compromising price and performance!

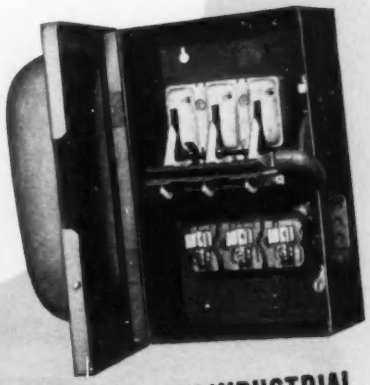
GENERAL PURPOSE

90,000 line designed for residential, commercial and other applications where price is limiting and the service factor is not great.



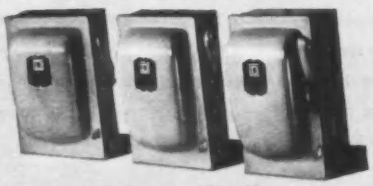
INDUSTRIAL

40,000 line designed for general industrial or institutional and commercial applications where the service factor is greater and price is an important consideration. MEETS BOTH GOVERNMENT AND NEMA SPECIFICATIONS FOR TYPE A SWITCHES.



HEAVY-DUTY INDUSTRIAL

80,000 and 50,000 line designed for mass production industries where price is secondary to continued performance under conditions of severe service and maximum safety. The 50,000 line is used where space is limited. BOTH ARE TYPE A but go far beyond those requirements.

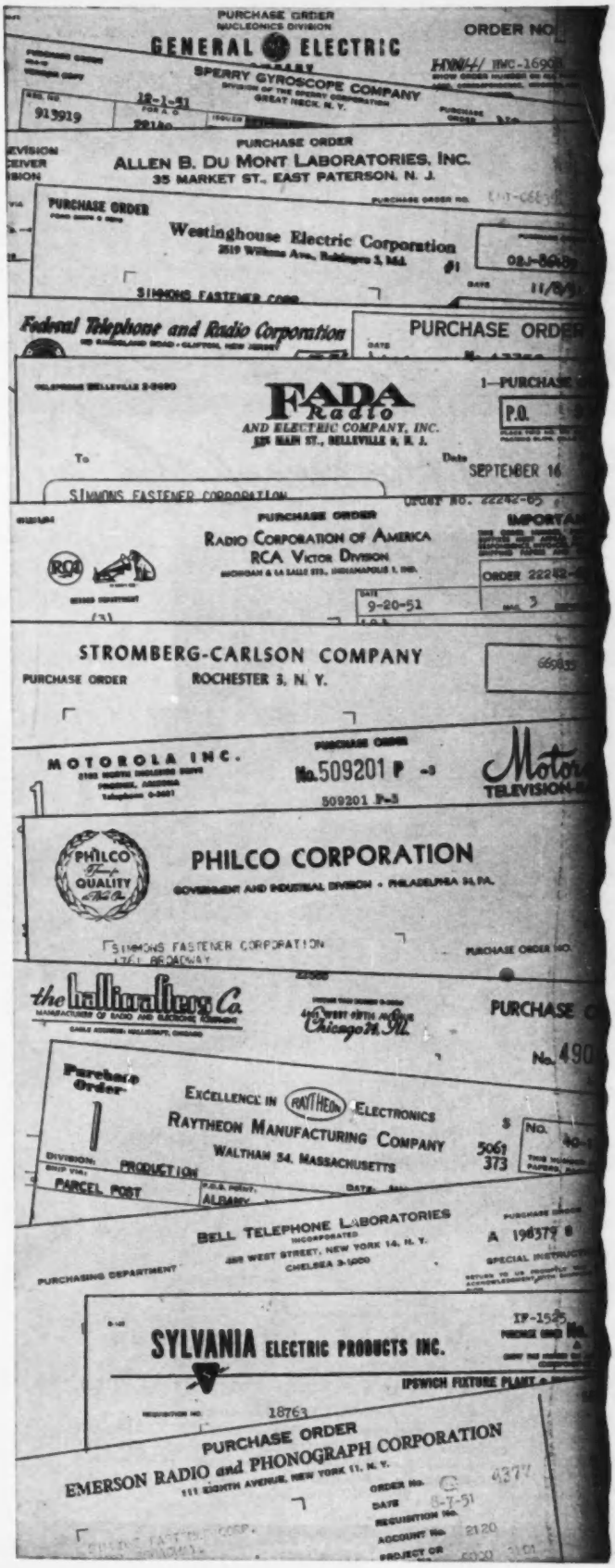


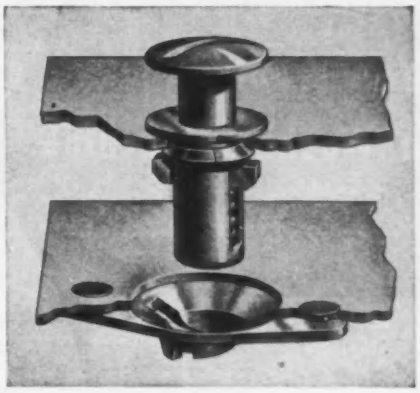
UNIFORM STYLING

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

1903 · 50 YEARS OF DESIGN LEADERSHIP · 1953





For Electronics:

Faster Assembly... Better Design

Why do leading electronic manufacturers order and re-order Simmons' QUICK-LOCKS in quantity? For good dollar-wise reasons:

IN ASSEMBLY—

- No special tools are needed for installation.
- Flexible mounting takes care of curved sheets and misalignment.
- Various material thicknesses can be handled.

IN DESIGN—

- Initial loads taken by helical spring. Increased loads carried on solid supports.
- 90-deg. rotation locks and unlocks fastener.
- Stud is self-ejecting when unlocked.
- Stud is self-aligning. Makes mounting and demounting detachable panels simple.

QUICK-LOCK can help reduce your assembly costs and can add unusual advantages to your designs. Send for data and samples today.

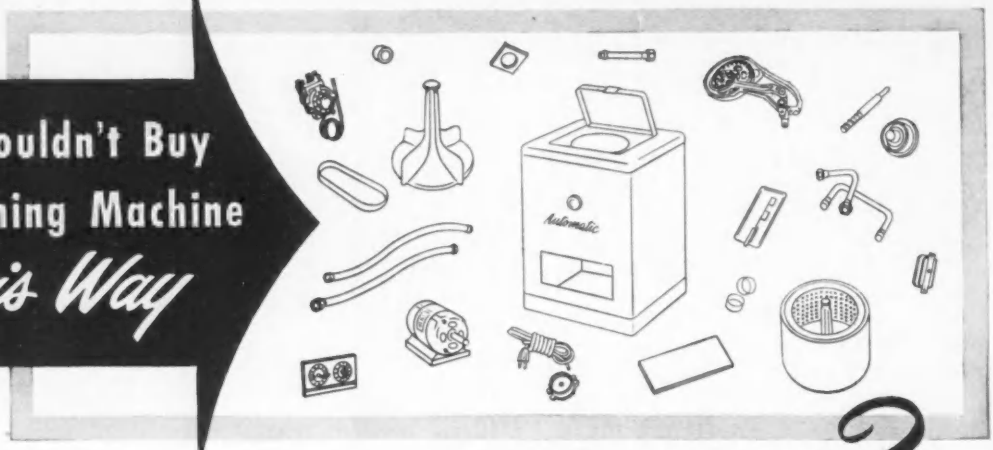
SIMMONS FASTENER CORPORATION
1751 No. Broadway, Albany 1, New York

Simmons

QUICK-LOCK
LINK-LOCK
SPRING-LOCK
ROTO-LOCK

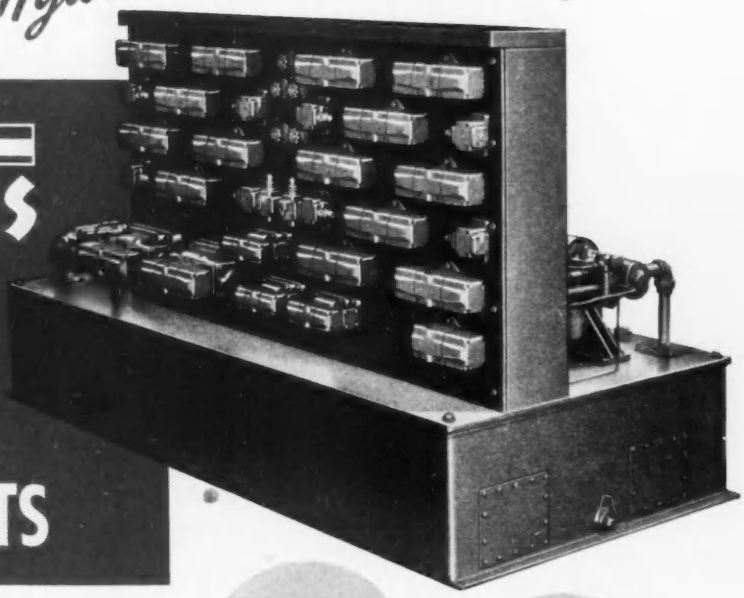
Fasteners that improve products and reduce assembly costs.

You Wouldn't Buy a Washing Machine *This Way*



Then Why Buy Hydraulics Piecemeal?

VICKERS *Custom-Built* HYDRAULIC POWER UNITS



You would never go to the trouble of buying automatic washing machine parts and assembling them yourself. It would take a lot of time and patience and trouble. For one thing the maker could not risk guaranteeing the finished job. You buy a washing machine as a unit, and want the undivided responsibility of the manufacturer.

Then why buy hydraulics piecemeal when there are so many advantages in a Vickers Custom Built Power Unit? It is built to meet your individual requirements, in a compact, neat, self-contained "package." It includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls etc. as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings etc.). Hydraulic connections are grouped in a convenient manifold.

Hydraulic design is simplified and improved, and you save substantially on installation and maintenance cost. Vickers takes undivided responsibility for the entire hydraulic system and you get the benefit of Vickers skill and experience. These advantages are important to both the machine builder and his customer.

Ask the nearest Vickers factory-trained application engineer to send you new Bulletin 52-45 or to make a personal call.

Improve and Simplify Hydraulic Design

Reduce Installation and Maintenance Costs

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:

ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND
DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA (Metropolitan) • PITTSBURGH
ROCHESTER • ROCKFORD • SEATTLE • TULSA
WASHINGTON • WORCESTER

6071

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

put 43 years of experience to work for you...

DIE CASTINGS BY STEWART

Services Available

Designing • Engineering

Die Making • Metallurgical Control

Most Modern Die Casting Equipment

Complete Machining, Polishing and Assembly Facilities

small . . . large

. . . simple . . . intricate

In zinc, aluminum or magnesium

Stewart DIE CASTING

A DIVISION OF... STEWART SW WARNER

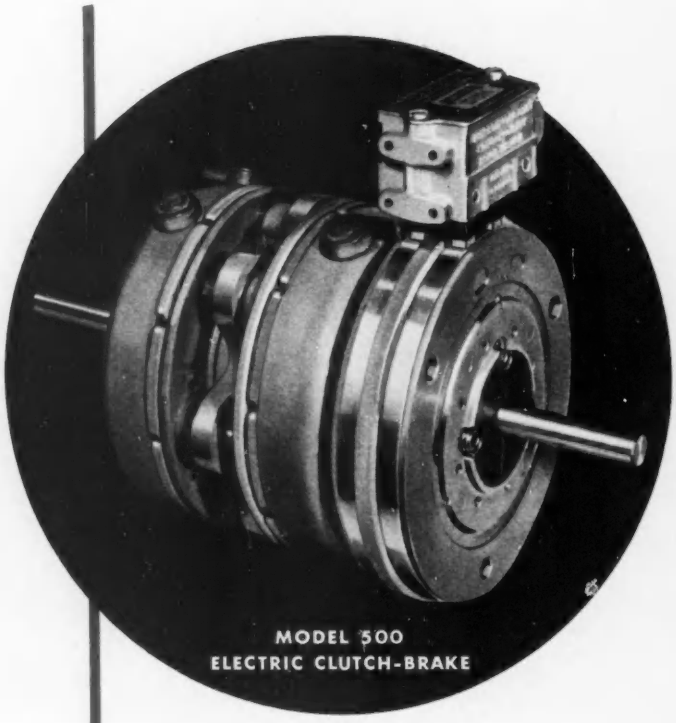
CHICAGO, ILL., 4535 FULLERTON AVE...BRIDGEPORT, CONN., 275 WARREN ST.

40% fewer parts...25% more accuracy with Warner Electric Clutch-Brake on modernized Stokes & Smith packager

WARNER

electric motion control

- **controls filling operation within ±2%**
- **permits 40% reduction in working parts**
- **cuts set-up time in half**
- **reduces assembly time and cost**
- **simplifies control**



MODEL 500
ELECTRIC CLUTCH-BRAKE

It's always "time for a change" when you can make obvious design improvements like these—so easily!

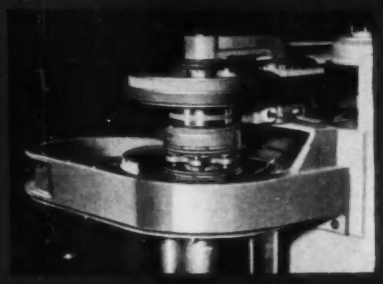
This new Model "EG" Universal Filler made by Stokes and Smith Company, Philadelphia, Pa., is faster and 25% more accurate . . . easier to set up and simpler to operate . . . more streamlined and less costly to manufacture—all direct or indirect advantages of using the Model 500 Warner Electric Clutch-Brake!

Warner units stop and start the auger filler. They permit compact mounting of all working parts above the filling station—keep parts free from dust and dirt. Cleaning maintenance is reduced. Streamlined design looks neat and pleasing to the eye. Clutch and Brake are self-adjusting. Electrical operation permits simplified, pushbutton control. Fast, precise braking controls accuracy of filling within ±2%.

Warner Electric Clutches and Brakes have applications on almost any machine that stops and starts. Perhaps they can improve your machine, with only simple modifications, enough to give you a real competitive edge . . . or open new replacement sales opportunities. Your Warner Representative will show you how!

ELECTRIC BRAKES & CLUTCHES

FOR INDUSTRIAL APPLICATION



New drive, through Warner Electric Clutch-Brake, has 40% fewer parts. No cams or sprockets. Never needs adjustment.

Clutch-Brake is mounted directly on auger filling shaft above planetary gearing. Requires only 5¾" shaft space.

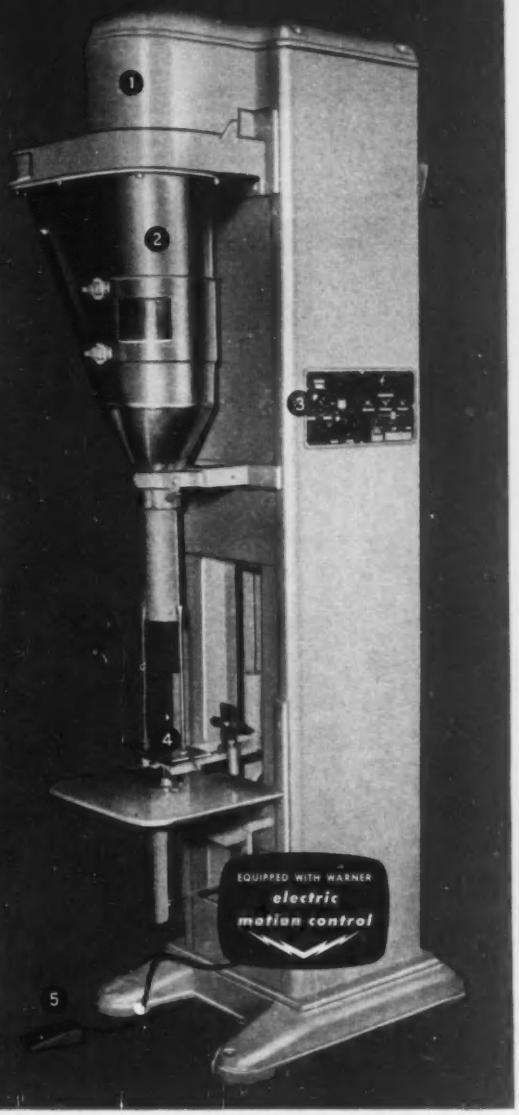
1. Facilitates streamlining—Compact Warner Unit permits enclosure of all working parts above filling station. Reduces cleaning maintenance.

2. Controls feed accurately—Fast, electrical actuation stops feed of powder from hopper when scale registers predetermined weight.

3. Simplifies control—Electrical Clutch-Brake permits fast, finger-tip control from panel near the operator. Speeds set-up.

4. Automatic operation—When scale registers correct weight of package, electrical signal stops auger feed precisely within ±2%.

5. Simplifies cycling—Foot-pedal clutch actuation starts feed easily, instantly. Filling cycle pre-timed to pace the machine operator.



Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for their small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric eyes, pushbuttons, etc. Rate of application is accurately controlled to synchronize motions—give exact degree of speed and power required for your machine operation.

CONTROL ENGINEERING SERVICE . . . Warner offers complete application and control engineering service and field assistance. If you have a clutching, braking, tensioning, indexing, or speed-control problem, consult experienced Warner brake and clutch specialists for reliable recommendations on torque, heat, electrical controls, capacity, etc.

FREE—Helpful data on clutch and brake selection. Paste coupon to letterhead or postal card—mail today.

Warner Electric Brake & Clutch Co., Dept. PE, Beloit, Wis.

☐ Please send your FREE Bulletin, WEB 6069.

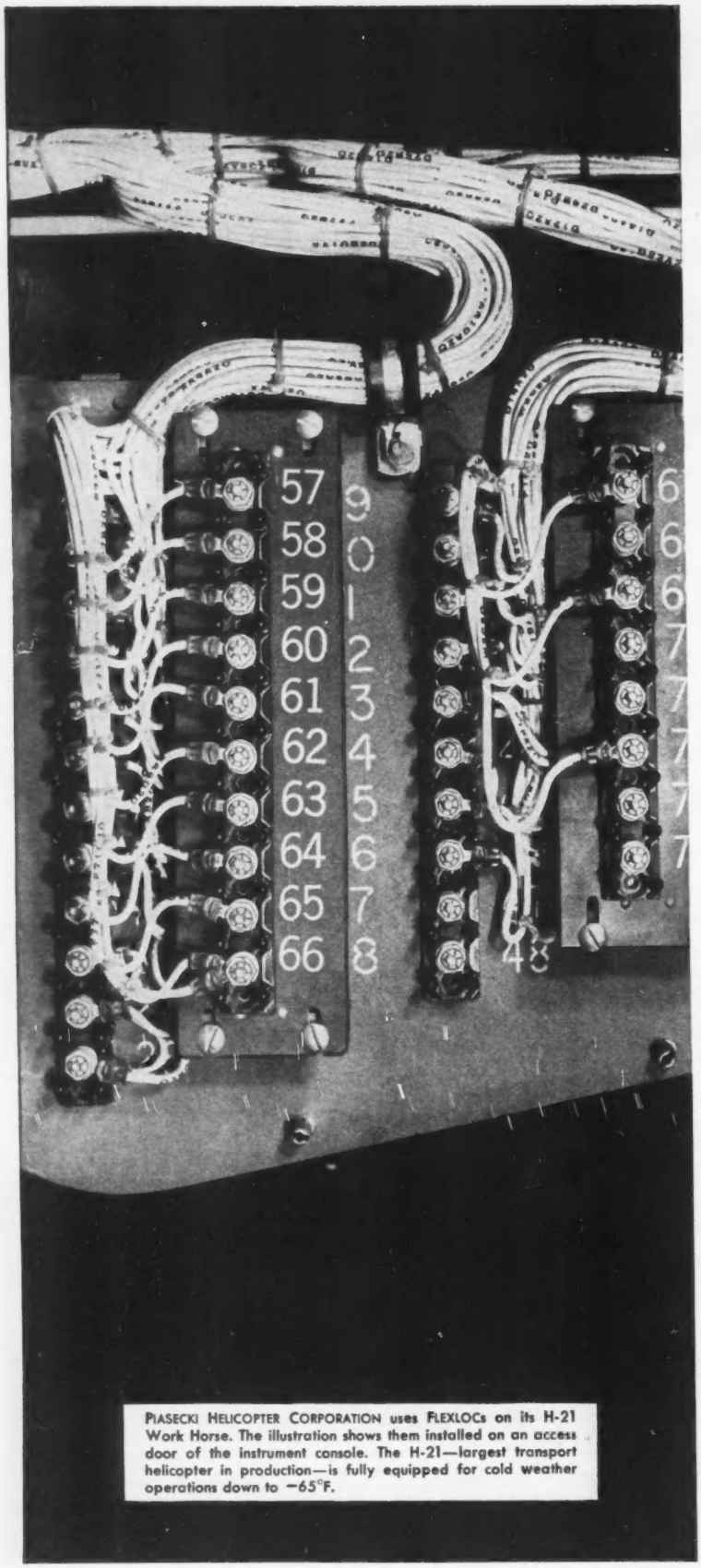
☐ Would like to see working demonstration.

Firm Name_____

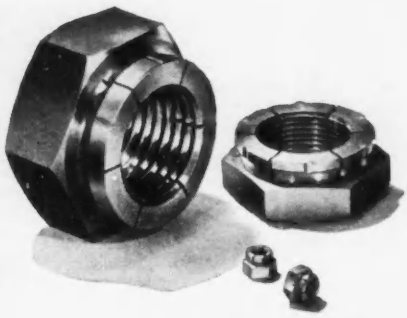
Individual_____ Title_____

Address_____

City_____ State_____



PIASECKI HELICOPTER CORPORATION uses FLEXLOCs on its H-21 Work Horse. The illustration shows them installed on an access door of the instrument console. The H-21—largest transport helicopter in production—is fully equipped for cold weather operations down to −65°F.



Why use FLEXLOC locknuts?

The answer is simple. They hold assemblies together, and won't work loose like ordinary nuts. Once you install these one piece, all metal nuts, you can forget them. Yet they can be easily removed and can be reused again and again.

No fastening job is too tough for a FLEXLOC. Whether it's on an access door of a Piasecki Helicopter or the picker stick of a high speed loom, a FLEXLOC stays put.

FLEXLOCs save production and maintenance time. They are one piece, all metal—nothing to assemble, come apart, lose or forget. Standard FLEXLOCs have higher tensile than most other nuts—and because they are all metal, are not affected by temperatures to 550°F.

SPS can deliver any quantity of FLEXLOCs in a wide range of sizes. Stocks are carried by industrial distributors. Write for literature and samples. SPS, Jenkintown 28, Pa.

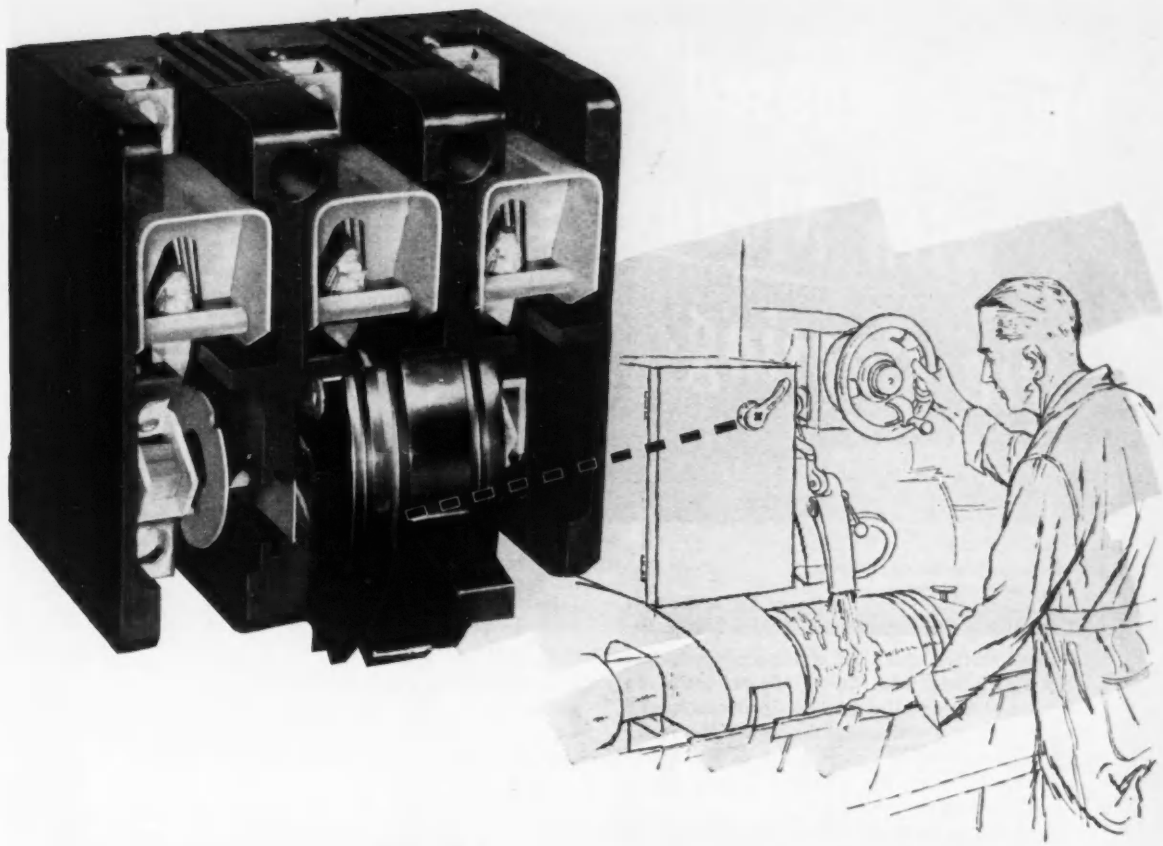
FLEXLOC®

LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE



New, compact, 60-amp De-ion® Switch only 4″ x 4″... has visible blades

Here's one way to ease the squeeze of mushrooming electrical devices in control panels.

It's Westinghouse's new, 60-amp Visible Blade De-ion Switch with self-indicating handle mechanism. A fusible or non-fusible disconnect for all types of control panels up to 50 hp, 600 volts a-c, this new switch is smaller, yet has higher interrupting capacity than any device of comparable rating. Saves critical mounting space—makes wiring and servicing easier.

It's handy, too. With fuses added, it's the only De-ion Switch with *visible* blades. The self-indicating handle eliminates opening doors to see the switch setting. The panel doors can be slammed without damaging the switch because the handle meshes with the switch setting.

De-ion arc quenchers, over-center toggle mechanism and silver-alloy butt contacts help make this switch just as rugged and dependable as every Westinghouse circuit protective device.

For full facts, call your Westinghouse Representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh, Pennsylvania. J-30143

YOU CAN BE SURE...IF IT'S Westinghouse

"Very pleased" with Mount Vernon Die Casting

CASE HISTORIES FROM MT. VERNON FILES

The tools shown here are Porter-Cable Machine Co's. Model 503 Sander and Model 511 Router.

Says Porter-Cable: "All of the castings for our No. 503 Sander and No. 511 Router are made by Mount Vernon Die Casting Corporation, and we are very pleased with the work done for us by this die-caster. The main frame on the sander required an especially difficult die, and Mount Vernon did an excellent job.

We find that die casting the parts which house our portable tools enables us to—

(1) hold down weight to a minimum;

(2) lower cost of tooling—since die casting can be held to such close tolerances that many machine operations can be eliminated;

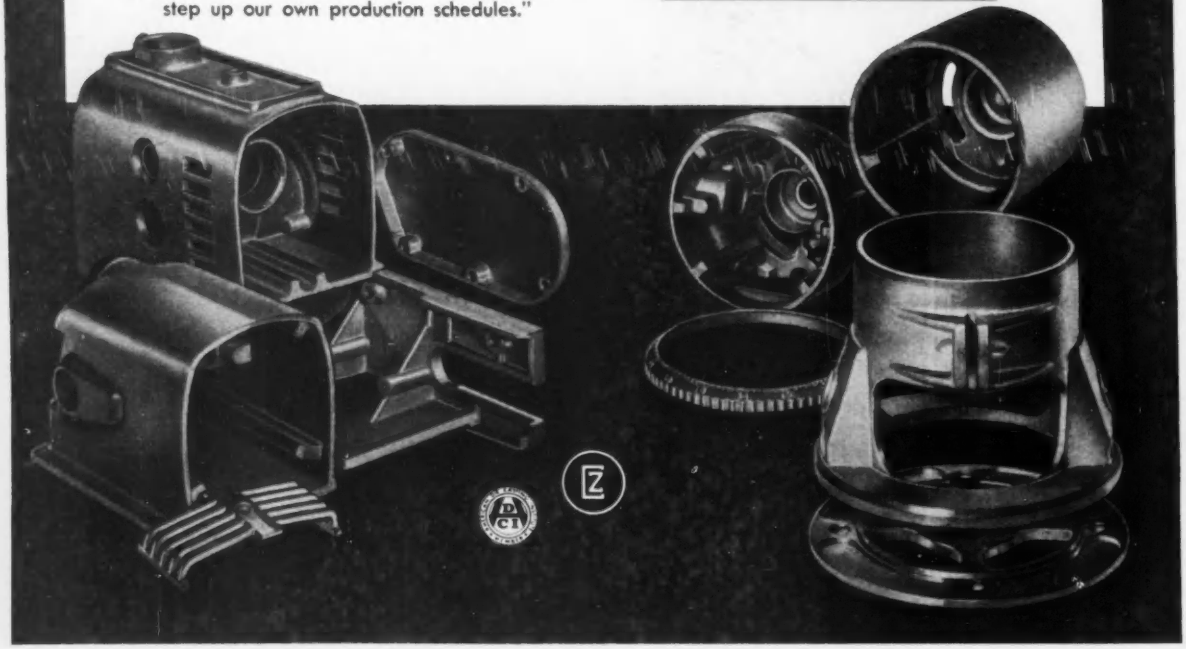
(3) get high quality castings at reduced costs;

(4) obtain faster deliveries—permitting us to step up our own production schedules."

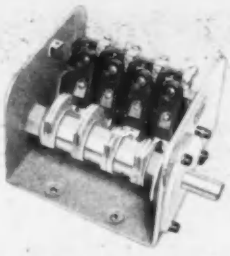
Here are compelling reasons why die casting merits serious consideration by every manufacturer with a metal product in the blueprint stage.

If you'll send us your specifications, we'll gladly put our long experience and specialized knowledge at your disposal . . . go to work to **please you in every respect,** just as we have pleased Porter-Cable.

MT. VERNON
DIE CASTING CORP.
MT VERNON, NEW YORK

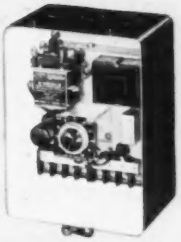


Bulletin 705 Reversing Switch for small a-c and d-c motors

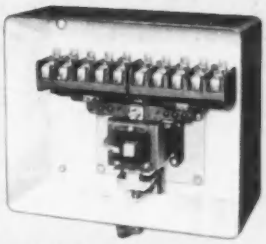


Bulletin 801 Rotating Adjustable Cam Limit Switch. Heavy duty

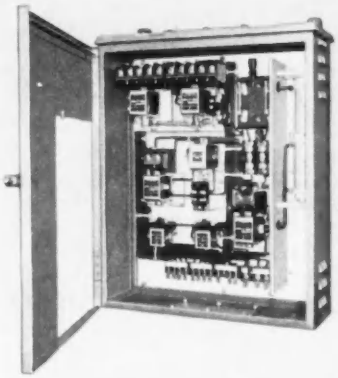
Bulletin 850 Motor Driven Timer for automatic process control



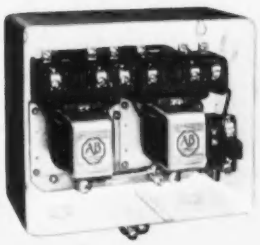
Bulletin 852 Electronic Time Delay Relay for precision timing



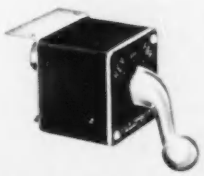
Bulletin 704 Nine-pole Permanent Magnet Contactor. Noiseless



Bulletin 290R D-C Reduced Voltage, Reversing Starter for marine service



Bulletin 205 Size 1 Reversing Switch for direct current motors



Bulletin 350 Drum Switch for reversing small a-c and d-c motors

Bulletin 365 Drum Controller for multispeed a-c motors

Some Useful Units in the

ALLEN-BRADLEY LINE

The standard Allen-Bradley line includes a wide range of solenoid operated across-the-line starters, combination starters, reversing switches, reduced voltage starters, and multispeed controls . . . not to mention an extensive variety of relays, contactors, and accessories.

And that is not all!

It also includes many other useful items . . . a few of which are shown here. They find application in the process industries, in marine service, in laundries, and in many other industries. All are designed for long, trouble free life and built to the widely recognized QUALITY standards that apply to the entire Allen-Bradley line.

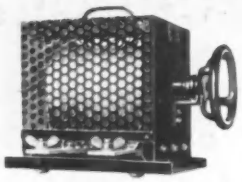
If you use motor controls . . . it will pay you to become acquainted with the latest Allen-Bradley Catalog. May we send you a copy?

Allen-Bradley Co.
1316 S. Second St. · Milwaukee 4, Wisconsin

A-B Quality

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

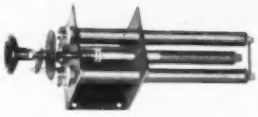
2-53-MR



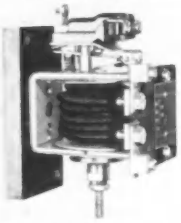
Bulletin 470 Graphite Disc Rheostat for laboratories

Bulletin 500 Knee and Foot Controllers for sewing machines

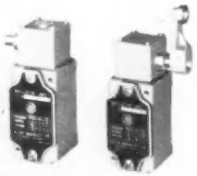
Bulletin 802 Foot Switch for heavy duty, rough service



Bulletin 410 Graphite Disc Rheostat for stepless control



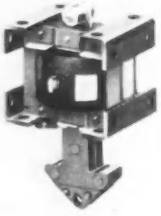
Bulletin 809 Instantaneous Current Jam-type Relay



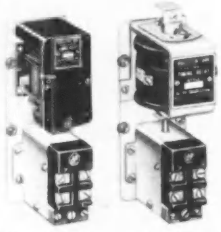
Bulletin 802 Limit Switches with various operating levers

Bulletin 600 Switch with overload breaker and pilot light

Bulletin 848 Dashpot Timing Relay. Maximum interval 30 sec.

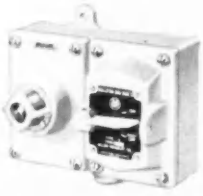


Bulletin 860 A-C Solenoid supplied in variety of ratings



Bulletin 849 Pneumatic Timers for machine tool service

Bulletin 202 D-C Contactors for applications up to 150 amperes

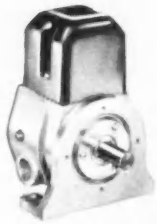


Bulletin 600 Watertight Starting Switch with pilot light

Bulletin 840 Float Switch operated by float and chain

Bulletin 800T Oiltight Push Buttons for machine tools

Bulletin 801 Rocker Arm Limit Switch for reversing service



Bulletin 808 Zero Speed Plugging Switch with magnetic lockout

Popular Accessories

in THE ALLEN-BRADLEY LINE

Above are shown a few Allen-Bradley control accessories. The variety of these units reveals the wide scope of the complete Allen-Bradley line. To machinery designers and plant engineers, the Allen-Bradley Catalog is a treasure house of standard control accessories which can be used in innumerable combinations to solve virtually any control problem. May we send you a copy of this Handy Catalog?

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

Look for the A-B trademark.
It is a guarantee of Quality

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

2-53-MR

SOLVING COMMON GASKET PROBLEMS

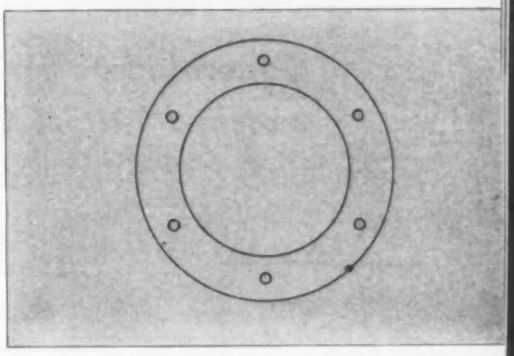
. . . with Accopac

Three interesting applications of Armstrong's new fiber gasket material

APPLICATION: Gear housing seal on helicopter

PROBLEM: Violent movement of the helicopter applied very high momentary loading on the gasket. Conventional fiber gaskets developed leaks and had to be replaced every 50 to 100 hours.

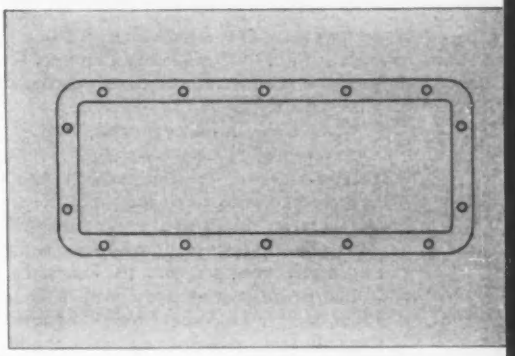
SOLUTION: This problem called for a tough gasket with high compressibility and great crush resistance. Accopac® was tried and found successful. Even under the extremely high pressures involved, Accopac gaskets lasted more than twice as long as those previously used—giving a tighter, more economical seal.



APPLICATION: Oil pan gasket on farm tractor

PROBLEM: The manufacturer had tried many different gasket materials to seal the oil pan of his tractors. However, no matter which type he tried he got oil leaks—and subsequent unsightly dirt accumulations on the engine block wherever it became wet with oil.

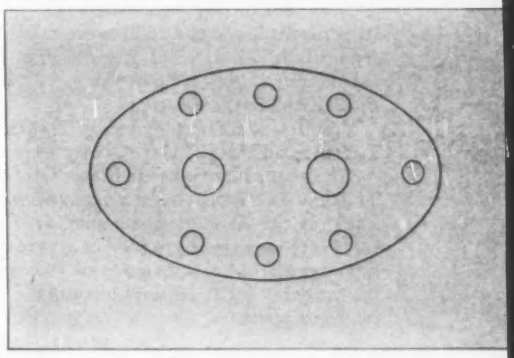
SOLUTION: Accopac was tried, and it proved completely satisfactory. In 2500-hour laboratory tests and in 3 months of field tests on tractors, Accopac gaskets didn't develop a single leak. As a result, there was no accumulation of oil to collect dirt. Accopac gave the tight, dependable seal that was needed for this particular application.



APPLICATION: Oil control valve cover gasket

PROBLEM: The glue-glycerine binder of conventional plant fiber gaskets attracted moisture from the air and helped corrode aluminum and steel components of the valve.

SOLUTION: 1/32" Accopac now does the sealing job with no trace of corrosion. Accopac contains no corrosive agent, and its latex binder does not attract moisture. Neither can Accopac gaskets ever leak through drying out and cracking. The latex binder is non-volatile and non-extractable.



Send for this helpful gasket manual

If you have a tough sealing problem, investigate Accopac. It's a new kind of fiber gasket material, made by an improved beater-saturation process that locks each fiber in an even coat of rubber. This uniform composition gives Armstrong's Accopac its exceptional crush resistance.

Accopac also has unusual compressibility, dimensional stability, and imperviousness. Get your copy of Armstrong's 1953 Gasket Materials folder for complete facts on Accopac and other Armstrong's Gasket Materials. Call your nearest Armstrong Industrial Division office or write direct to Armstrong Cork Company, Gaskets and Packings Department, 6202 Arch Street, Lancaster, Pennsylvania.

ARMSTRONG'S ACCOPAC

PROBLEM:

To obtain uniformity of performance between two thermostat elements used in thermal type demand meters

SOLUTION:

General Plate provided the solution with identically matched TRUFLEX® Thermostat Metal Coils

Manufacturers of thermal type demand meters were faced with the problem of obtaining two thermostat elements for each meter that had identical performance characteristics.

When these coils were made individually each one had to be tested 100% and then paired together with the coil that had, as near as possible, the same operating characteristics for use in each meter. This meant costly testing procedures, rejects and often unsatisfactory performance.

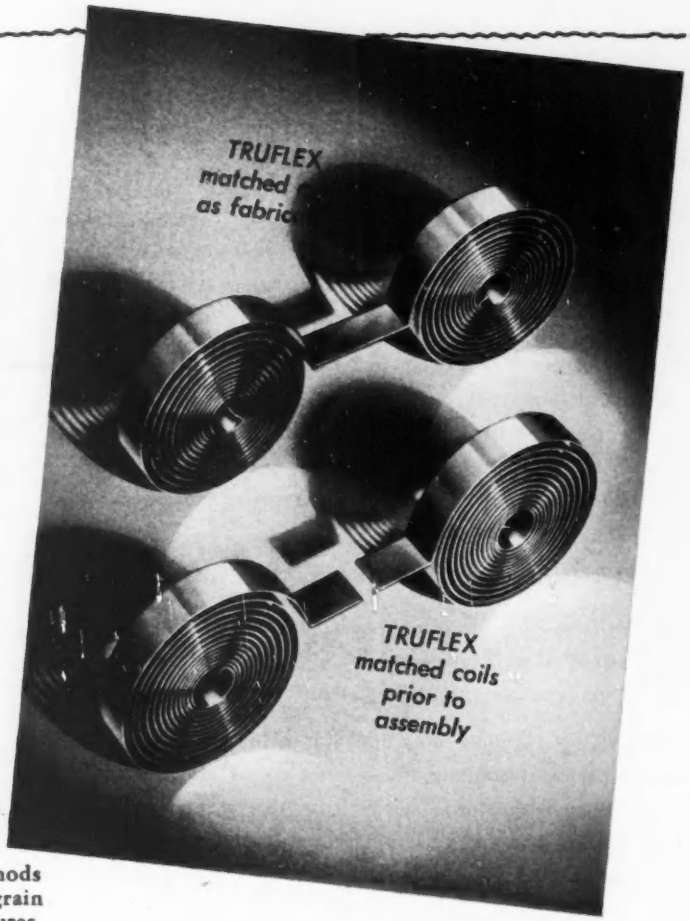
The problem was presented to General Plate, whose engineers quickly found the solution. *Matched coils* were made from adjacent sections of a single *Truflex* thermostat metal strip as illustrated. Since the coils were made from identical material, they were automatically *paired* with the same uniform operating characteristics.

You, too, can save by using *Truflex* Thermostat Metals. Here's why —

When you buy General Plate *Truflex* Thermostat Metal you can be sure that not only the first lot meets specifications but every succeeding order is a twin . . . has identical characteristics to the original lot . . . whether it be days, months or years apart.

Advanced General Plate production methods insure positive consistency in tolerances, grain structures, expansion, hardness, etc. It assures maximum uniformity of materials which reduces costly rejects and guarantees highest quality performances.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, silver solders, composite contacts, buttons and rivets, *Truflex*® thermostat metals, Alcuplate®, platinum fabrication and refining, #720 manganese age-hardenable-alloy. Write for Catalog PR700. It gives information on these and other General Plate products.



Have You a Composite Metal Problem? General Plate can solve it for you

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
12 FOREST STREET, ATTLEBORO, MASS.

Parts molded of Du Pont nylon by and for Remington Rand, Inc., Bridgeport, Conn.

Parts of Du Pont NYLON cut wear and noise in electric shaver motor . . .

need no lubrication . . . trim production costs

The rotor of the Remington "60" Electric Shaver spins 8,500 times per minute to push 132 blades through 16,000,000 cutting strokes. To help provide long, efficient service of the shaver, four key parts had to be made of a material possessing outstanding mechanical, electrical and thermal properties. These parts are the coil form, oscillator bushing, oscillator insulation and contact lever insulator.

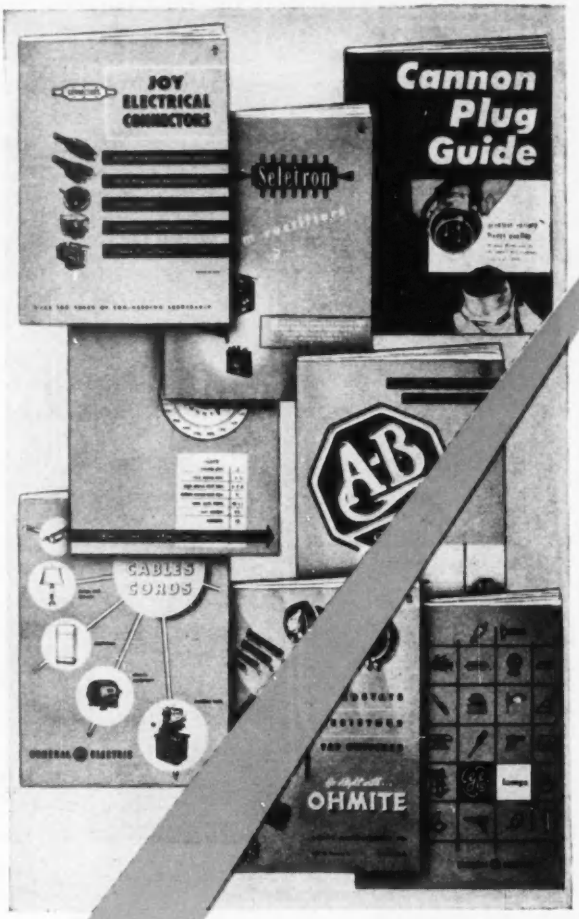
Remington engineers specified that each part be made of Du Pont nylon plastic. Nylon's toughness, strength in thin section and heat resistance provide for maximum coil form efficiency and durability. Du Pont nylon has a low coefficient of friction and excellent bearing characteristics . . . insures long service life of all moving parts and wearing surfaces without lubrication in many applications.

Parts molded of Du Pont nylon in this and many other applications will operate continuously at temperatures to 250°F. They assure positive electrical insulation . . . help dampen noise. And they can be economically mass-produced by injection molding . . . keep production costs down.

The many unique properties of Du Pont nylon may be able to help you develop or improve a product. For full information on nylon and other Du Pont plastics, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department, District Offices:
350 Fifth Avenue, New York 1, New York
7 S. Dearborn Street, Chicago 3, Illinois
845 E. 60th Street, Los Angeles 1, California

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS



looking

"...a great time saver."

S

for electrical parts?

reach for your Product Design File

All these manufacturers' catalogs are instantly available in Section 3 of your Product Design File. They contain comprehensive information on motors, controls, and other electrical parts.

The other sections of this File contain additional catalogs covering a wide range of materials and equipment . . . useful and up-to-date information on product forms, characteristics, performance and use.

This collection of 201 manufacturers' catalogs is grouped in sections according to products, or use of products, so that you can readily compare one product with another. Indexes of manufacturers, products and trade names lead you quickly and easily to the catalogs you are looking for.

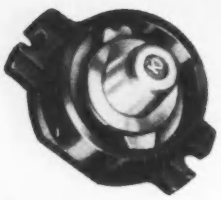
Sweet's is working constantly to get more manufacturers to send you their catalogs in this easy-to-use form. If you fail to find what you want, please tell us.

Sweet's Catalog Service

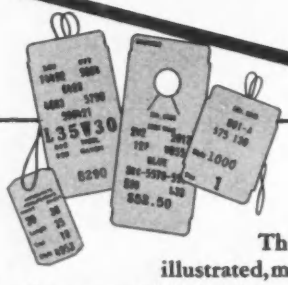
DIVISION OF F. W. DODGE CORPORATION

119 WEST 40TH STREET, NEW YORK 18, N. Y.

KLIXON MOTOR PROTECTORS



Help Keep Soabar Ticket and Label Marking Machines "Ticking"



The Soabar Thermaply illustrated, manufactured by Soabar Company, Philadelphia, Pennsylvania, is the first marking machine in which heat is successfully used for attaching labels.

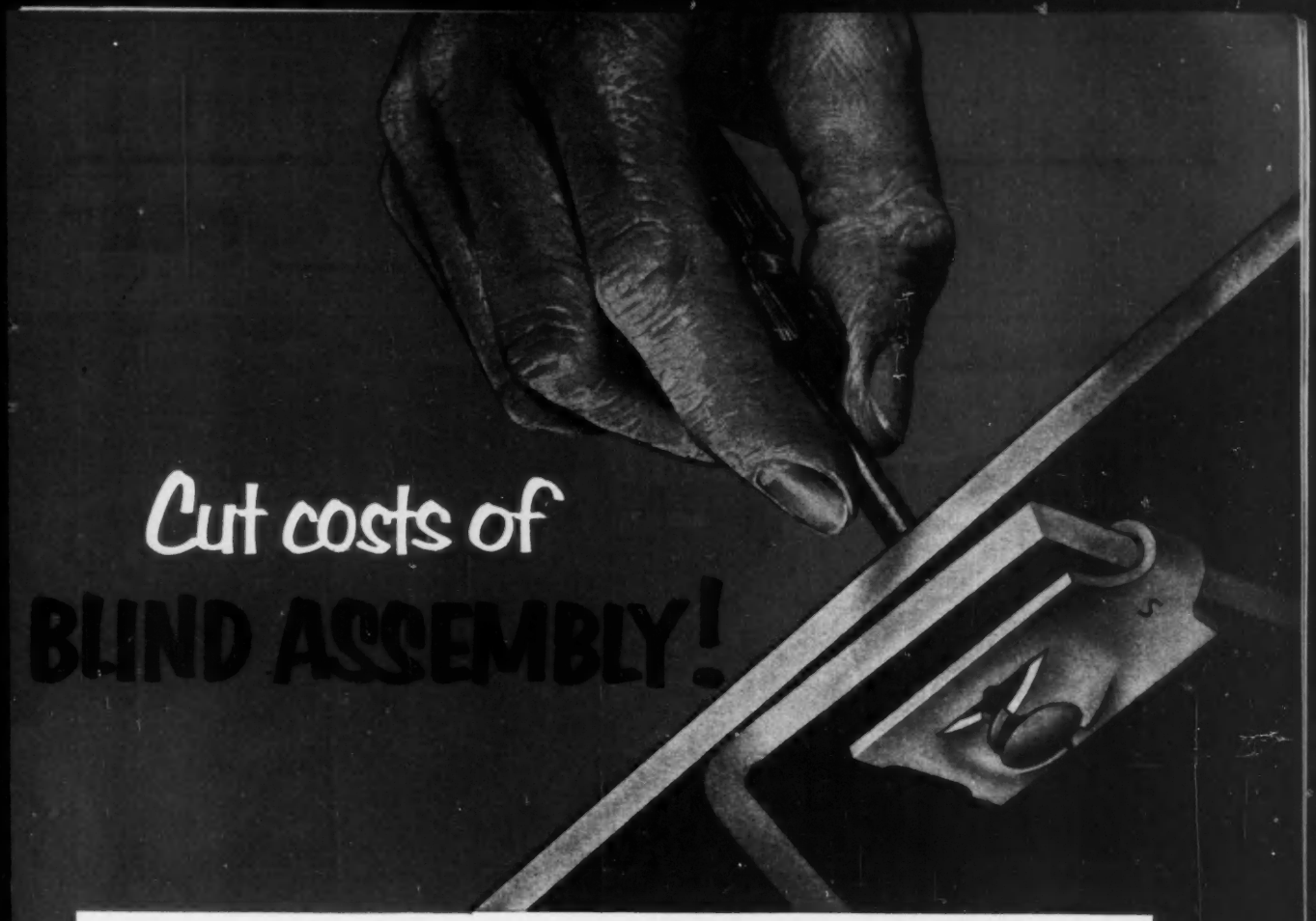
To keep the drive motors in the Thermaply and other machines operating dependably and safeguard them against failures through motor burnouts, the Soabar Company specifies and uses motors with built-in Klixon Protectors.

Mr. David Tamaccio, Chief Engineer at Soabar has this to say about Klixon Protectors — "*The motor protection afforded by Klixon inherent overheat protectors has been an asset to the maintenance and good operation of Soabar Ticket and Label Marking and Attaching Machines.*"

You, too, can keep motors in your equipment dependable by specifying and using Klixon protected motors. They will reduce maintenance costs, service calls and repairs and replacements. The additional cost is low. The benefits are exceptionally worthwhile.

KLIXON

SPENCER THERMOSTAT
Division of Metals & Controls Corporation
902 FOREST STREET, ATTLEBORO, MASS.



SHAKEPROOF® "SPEED NUTS*"

SELF-RETAINING FEATURE ELIMINATES RIVETING, STAKING OR WELDING

They're easy to install without special tools... can't clog with paint... make screw driving faster ...lock tight with unique thread gripping action and assure a strong, shock resistant fastening.

SHAKEPROOF

"Fastening Headquarters"®

DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois • Offices in principal cities

America's Great Resources Plus A Free Economy Made This Business Possible!

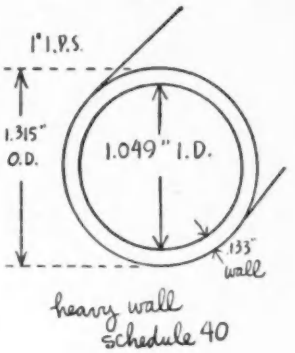
*T.M. Reg. U. S. Pat. Off. by Tinnerman Products, Inc.

FREE ...TESTING SAMPLE KIT

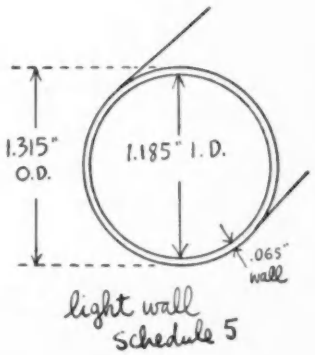
contains all three self retaining types of SHAKEPROOF "SPEED NUTS", "U" and "Latching", in a selection of sizes. Make your own test and prove the savings. Send for your kit today!

Why pay for Schedule 40 pipe where Schedule 5 is more than adequate ?

Back in the days when iron pipe was virtually the only kind available, it was necessary to specify this



But today with the high strength/weight ratio of stainless steel, the great majority of pipeline and process applications will have an ample margin of safety with this



All sizes of Carpenter Schedule 5 pipe will easily handle 150 psi working pressures. Sizes under 1½" will safely handle considerably higher pressures.

By specifying this light wall stainless pipe you gain many advantages:

1. You save money. Schedule 5 pipe costs about half as much per foot as Schedule 40.
2. Schedule 5 has the same O.D. as Schedules 10, 40 and 80—for hook-up with existing lines as well as for new installations.
3. Its larger I.D. increases flow and capacity in pipelines, exchangers and other equipment.
4. It's lighter. This means quicker and easier installation.
5. You can save 10% to 25% on valves, fittings, weld rods, etc., because smaller O.D. material can frequently be used.
6. Fittings are available from several manufacturers . . . and stocks of Schedule 5 pipe are carried by conveniently located Carpenter distributors.
7. Tubing sizes can now be replaced with light wall pipe . . . for ready hook-up with standard valves, pumps, etc.

Light wall Schedule 5 pipe saves dollars—and makes a lot of sense!

For complete data on Carpenter Schedule 5 Stainless Pipe, call your nearest Carpenter distributor or write us direct. We'll be glad to send you the information you need. THE CARPENTER STEEL COMPANY, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

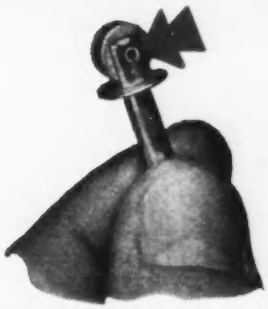
Carpenter

THE U.S. NEEDS YOUR STEEL SCRAP NOW

STAINLESS TUBING & PIPE

Analysis · Tolerance · Finish

• guaranteed on every shipment



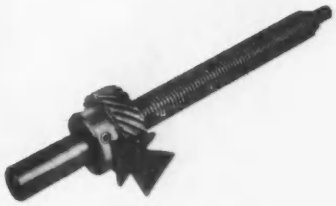
AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.

AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.

AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

YOUR IMPORTANT FASTENING JOBS

are cheaper . . . faster, with ROLLPIN TRADE MARK

Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

Rollpin is reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA

MAIL COUPON TODAY. If your present operations or plans include the above applications—or set screws, rivets, hinge pins, cotter pins, pivot pins, taper pins—you can't afford to be without complete details on Rollpin. Write now—find out how much faster and cheaper Rollpin can do the job.

Section R1-22, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

Please send me the following free information on ESNA self-locking fasteners:

☐ Rollpin bulletin and sample Rollpins ☐ AN-ESNA conversion chart
☐ Elastic Stop Nut Bulletin ☐ Here is a drawing of our product. What fastener do you recommend?

Name_____ Title_____

Firm_____

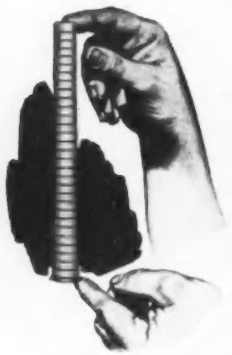
Street_____

City_____ Zone_____ State_____

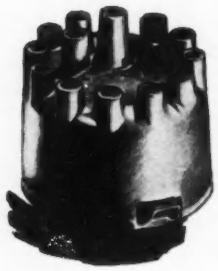
Two truly versatile plastics...
USCOLITE and ENRUP
...and what they made possible

Piping that has high impact resistance . . .

. . . piping that is resistant to corrosive solutions . . .

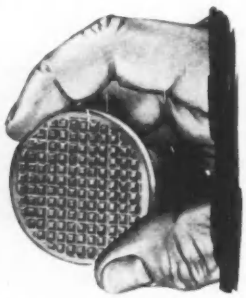


. . . textile warp tubes that do not chip, splinter, or roughen around the ends



. . . distributor caps with a toughness and flexibility new to plastics . . .

. . . knobs with great impact strength, unusual resistance to solvents, and excellent dielectrical properties . . .



. . . washing machine parts that have unusually high abrasion resistance and structural strength . . .

. . . printing-roll end bearings that have high chemical resistance and are produced by precision molding techniques.

Note varying degrees of flexibility of Enrup strips, offering a rigidity or flexibility unmatched by other plastics.

HERE are just a few of the hundreds of improved products made possible by Enrup and Uscolite. Every type of industry uses these wonder plastics, and the variety of uses is constantly increasing. Molded, extruded, and fabricated exclusively by United States Rubber Company engineers, they can be punched, sanded, sawed, nailed, bolted, and machined. The chances are that one or the other may be just what you require to give your product that competitive edge that means higher sales, greater profit.

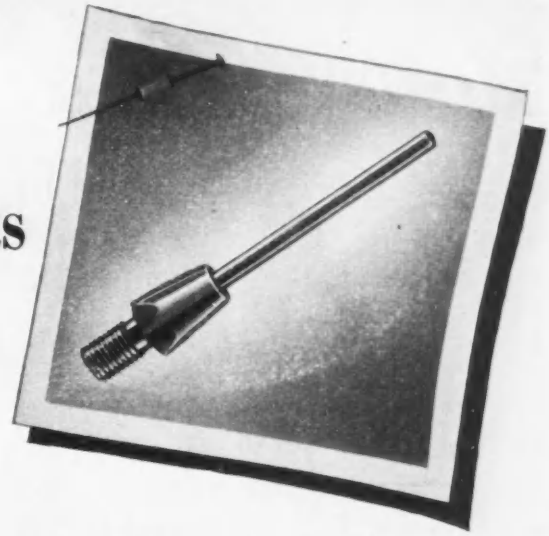
Write to the address below.

PRODUCT OF U.S. RUBBER — SERVING THROUGH SCIENCE

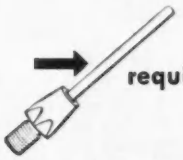
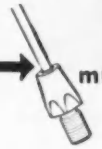
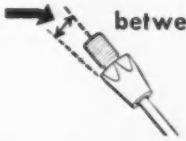
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

To Reduce Your Contact Assembly Costs



Use the same specialized experience that solved this problem . . .

This tungsten electrode  **requires grinding to a tolerance of ±.00025 of an inch to insure absolute concentricity. This braze**  **must withstand the centrifugal forces of the highspeed generator in which it is mounted. The hole in the chuck** **is held to a tolerance of ±.00025 of an inch. This angle**  **between the chuck and electrode is held to within ±6 minutes of a degree.**

Originally Mallory produced only the tungsten electrode for this assembly. Another firm manufactured the chuck, and a third did the brazing and chrome plating . . . a complicated, costly process. Now, Mallory produces the entire assembly. The customer's problems of quality control, sub-contracting and divided responsibility are entirely eliminated . . . and his costs are lower.

This is just one more example of how many manufacturers have improved the performance and lowered the cost of contact assemblies by having Mallory do the entire job. No matter what your requirements are, Mallory's specialized production facilities . . . experience in designing and mass-producing over 5000 different types of contacts . . . can turn out precision contact assemblies for you at lower cost.

Expect more . . . Get more from **P. R. MALLORY & CO. Inc. MALLORY**

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

P. R. MALLORY & CO. Inc. MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

It levels the path of power!

Six rubber balls are the connecting link between driving and driven unit. With the resiliency that only rubber can supply, they dampen the shocks of sudden starts and stops, and reduce or eliminate pulsation or other vibration-causing condition. They add life to the equipment they serve.

The rubber balls are tough, resilient, and long-lived. If or when necessary they can be quickly pushed out and replaced without dismantling the coupling or disturbing alignment.

With this coupling you get not only great shock abosorbing capacity and positive drive without slippage, but also freedom from noise, vibration, and the need for lubrication or other maintenance. Full details in the C-W Coupling Bulletin at request. Address Elliott Company Dept. TW, Jeannette, Pa.

ELLIOTT Company

CROCKER-WHEELER DIVISION

AMPERE, N. J.

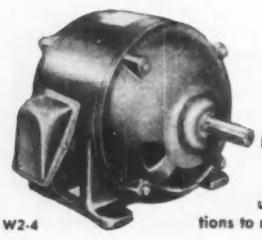
For large motors: RIDGWAY DIV., RIDGWAY, PA.

Plants at: JEANNETTE, PA. • RIDGWAY, PA. AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.

DISTRICT OFFICES IN PRINCIPAL CITIES

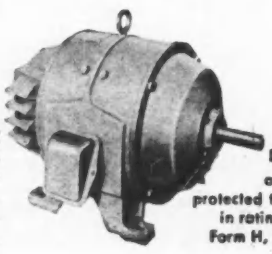
ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY

A FITTING COMPLEMENT TO ELLIOTT C-W MOTORS

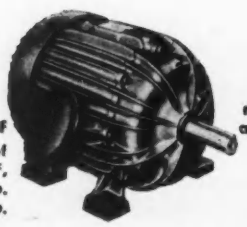


W2-4

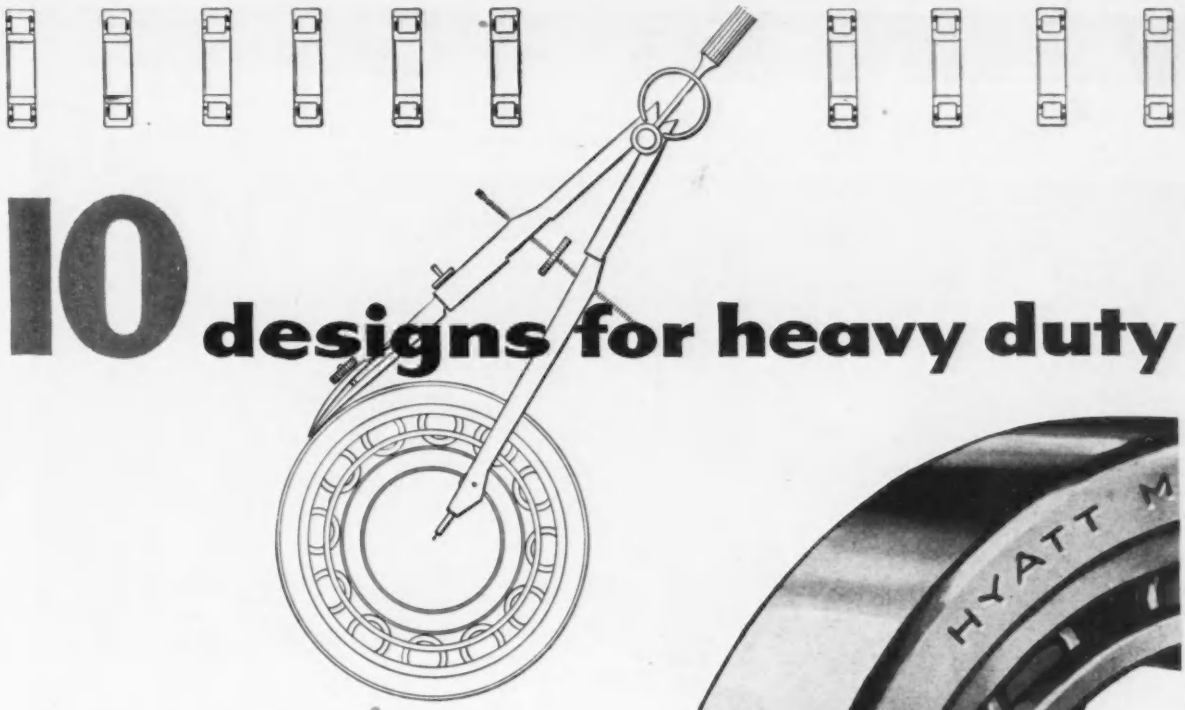
SQUIRREL-CAGE PROTECTED FORM BA
Open drippproof motor for general use. Many modifications to meet special needs.



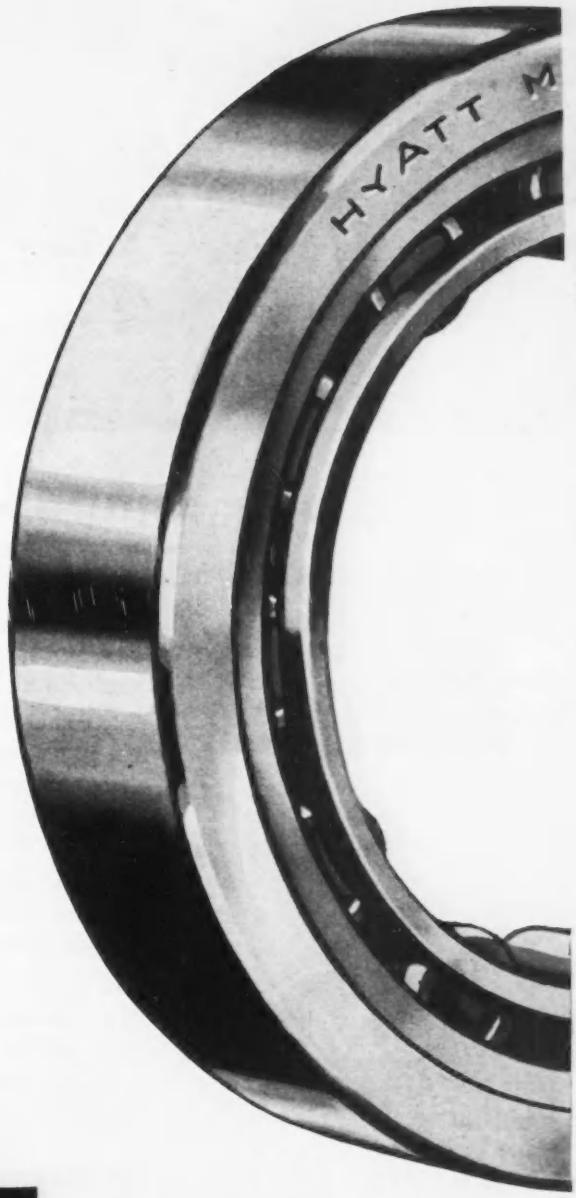
DC DRIPPROOF
and drippproof protected types Form F, in ratings to 7½ hp. Form H, 10 to 200 hp.



"SEALEDPOWER"
The famous C-W motor of ten-year reputation that cools and cleans itself with outside air blast. 3 to 125 hp. Also explosion-proof, 20 to 125 hp.



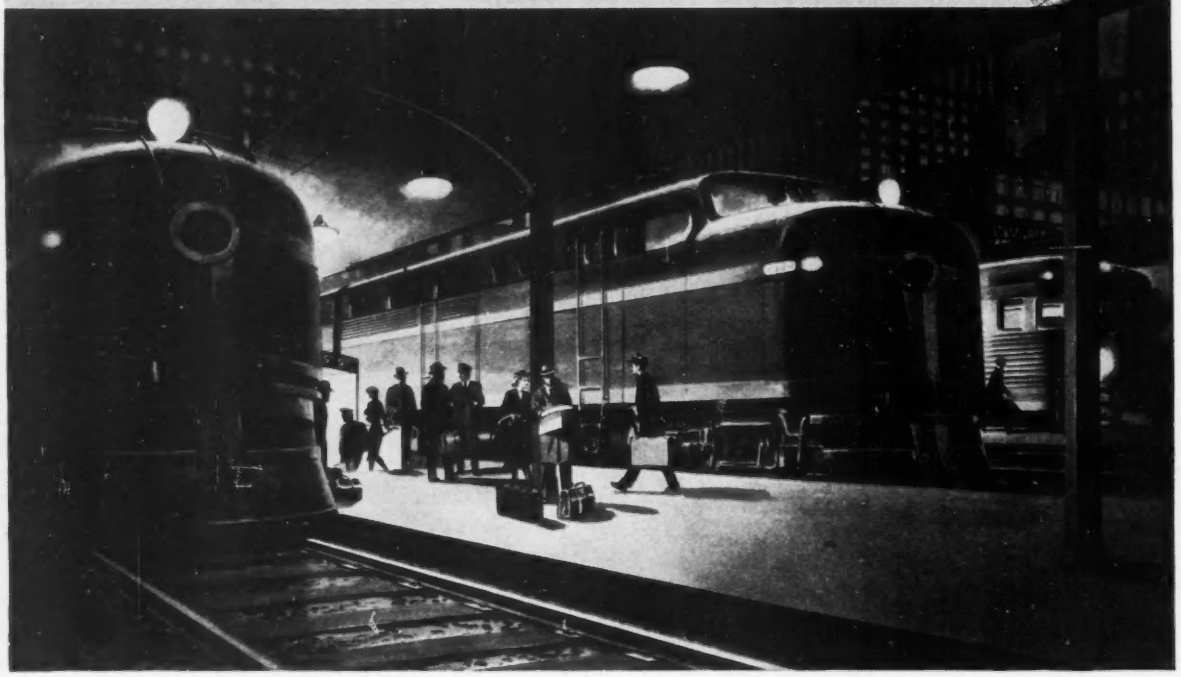
10 designs for heavy duty



Ten different Hyatt Hy-Load designs, each in a variety of widths and sizes, assure you the right bearing for every radial need.
Four Hy-Load designs have separable inner races, two have separable outer races and four are non-separable. All are high-capacity, cylindrical roller bearings for the heaviest radial loads and light or intermittent thrust loads.
All separable parts are freely interchangeable within the same size. This permits non-selective fitting after pre-assembling the two bearing parts in separable machine elements.
Whatever your radial load problem, Hyatt Hy-Loads or some of the other types of Hyatt bearings can provide the answer. Because Hyatt offers industry's most complete line of straight radial roller bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

See what adhesives are doing today!



Saving one company $400,000 a year

Corrugated steel sheet secured to steel plates by 3M adhesive

Diesel locomotives must work right around the clock, and the vibration encountered in their millions of operational miles makes it vital that all parts be designed to withstand plenty of punishment.

One manufacturer found that the plywood-steel side panels he was using, were deteriorating and needed frequent replacement. His design section suggested that an all-steel panel be substituted, and further study revealed that *a 3M adhesive could be utilized to hold the panel sections together.*

The new panel proved stronger, more resistant to vibration and torsional stress, and preliminary cost studies indicate that *the new style panel will save over $400,000 a year in manufacturing costs.*

See what adhesives can do for you . . .

If you're interested in making better products at lower cost, look into 3M adhesives and sealers. For more information contact your 3M representative, or write Dept. 42 for a brochure describing applications.

3M COMPANY

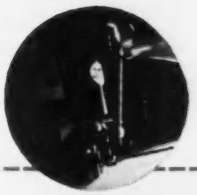
MINNESOTA MINING AND MANUFACTURING COMPANY

ADHESIVES·COATINGS·SEALERS

ADHESIVES AND COATINGS DIVISION • 411 Piquette Ave., Detroit 2, Michigan

GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 270 PARK AVE., NEW YORK 17 • IN CANADA: LONDON

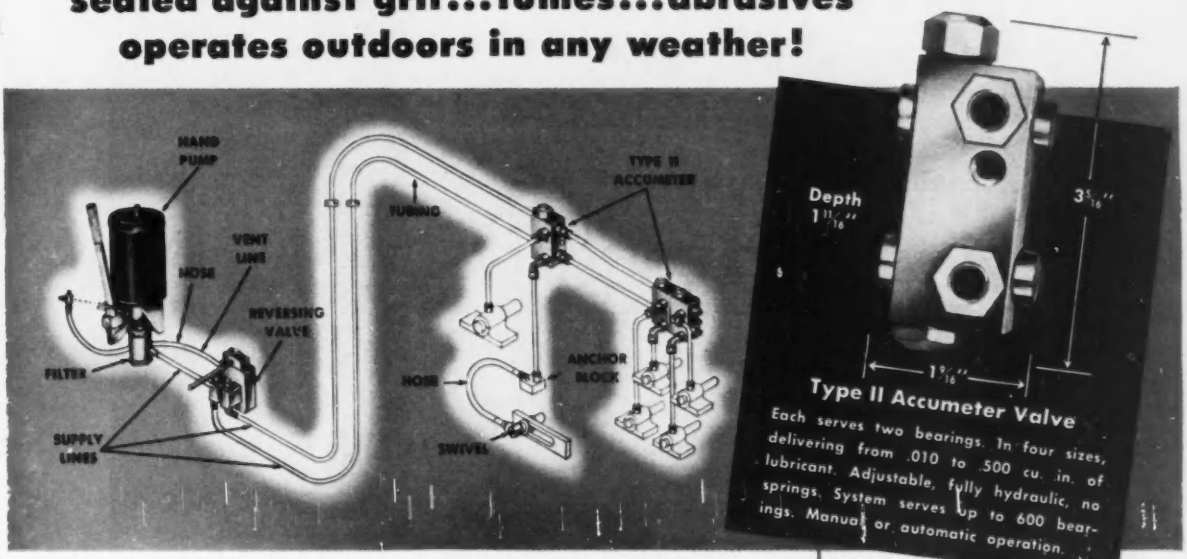
MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



developed... **for "tough-job" lubrication on the largest, heaviest machines...**

ALEMITE Accumeter® CENTRALIZED LUBRICATION

sealed against grit...fumes...abrasives
operates outdoors in any weather!



Alemite Accumeter Lubrication System delivers the exact, measured amount of lubricant to *all* bearings of a machine. In a fraction of the time required for hand lubrication–Accumeter measures and delivers lubricant–*while the machine is in operation!* No down time–no points missed. No wonder 95% of big plants buying machine tools want centralized lubrication!

Type II Accumeter is unmatched for simplicity of design. It's fully sealed and enclosed–yet may be serviced without being removed from machine. Operates in salt spray, severe acid or fume conditions–even totally immersed–because it may be painted or treated with non-corrosives.

Type II Accumeter System can serve single machines or groups–will handle any required lubricant–heavy or light. It is just one of three types of Accumeter Systems made by Alemite. One of them will serve your requirements.

offers...

ALL THESE ADVANTAGES!

- **Eliminates shutdown time for lubrication. Adds productive time to machine output.**
- **Seals completely against dirt, grit, water all the way from "Barrel-to-Bearing."**
- **Prevents bearing troubles due to neglect or use of wrong lubricant.**
- **Services *all* bearings–including those inaccessible or dangerous–in one operation.**
- **Avoids work spoilage and bearing repairs due to over-lubrication.**

FACTORY-TESTED . . . FIELD-PROVED

Proved in the field. Exhaustive tests showed *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, *equal to 122 years of twice-a-day service.*

ALEMITE®
REG. U. S. PAT. OFF.

A PRODUCT OF STEWART WARNER

Free–Alemite Accumeter Catalogue and Engineering Data Book.

ALEMITE, DEPT. T-23
1850 Diversey Parkway, Chicago 14, Ill.

Please send me my free copy of the Alemite Accumeter Catalogue and Engineering Data Book.

Name _____

Company _____

City _____ State _____

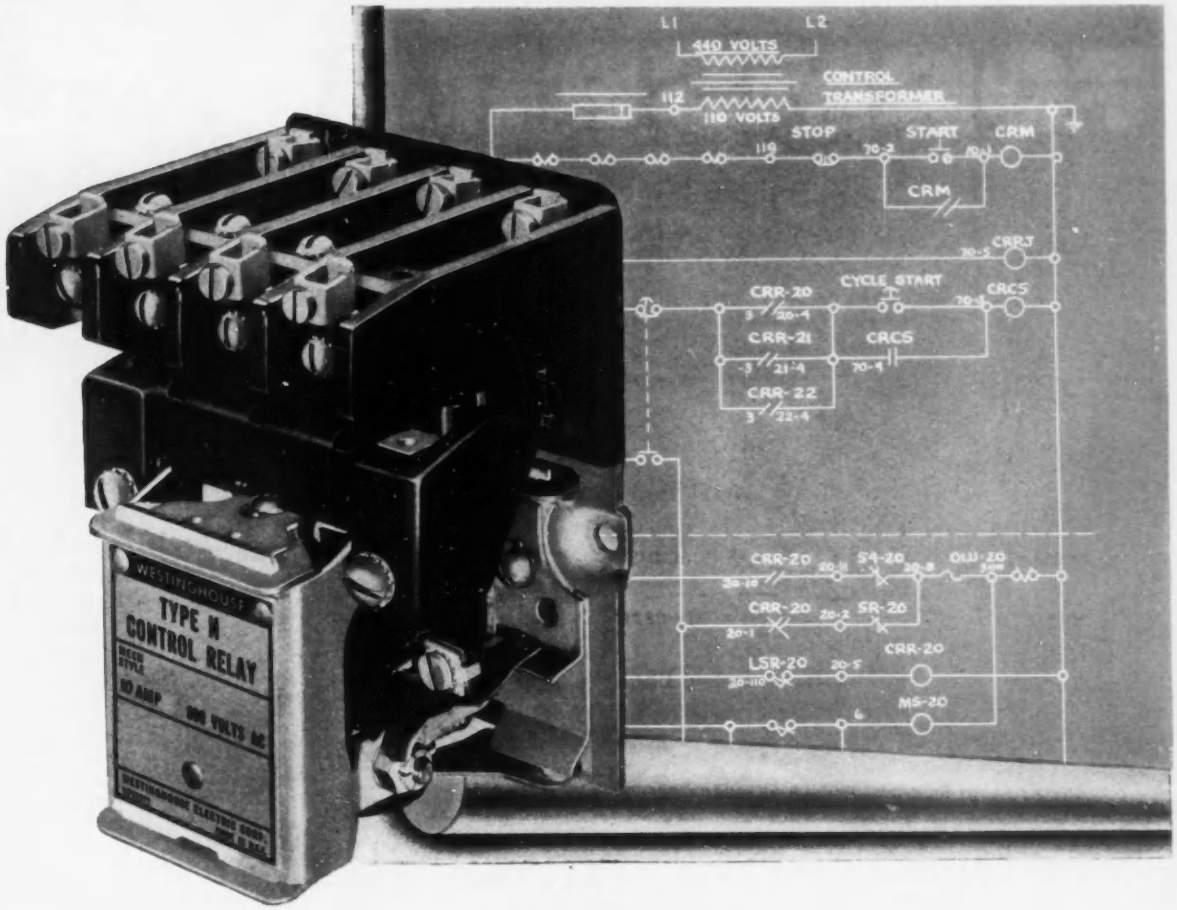
HEIM ROD ENDS

A single ball revolving in spherical bronze bearing inserts provides a larger bearing surface so that maximum radial and thrust loads are carried by Heim Unibal Spherical Bearing Rod Ends. The universal motion of the ball corrects misalignment of the shaft, or stud, in all directions.

WRITE NOW FOR COMPLETE CATALOG OF HEIM BEARINGS.

Typical of the thousands of applications of Heim Unibal Spherical Bearing Rod Ends are the trucks and busses made by The White Motor Company. Heim bearings are used on their diesel models 26PLTD, 22D, 24PLTD, 22PLTD, and WC 28-PLTD.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT



NEW! TYPE N CONTROL RELAY

Rugged • Compact • Versatile

Designed into the new Westinghouse Type N Relay are all the outstanding features of the Life-Linestarter. Here are a few of many top advantages you get:

Knife-edge bearing for minimum wear
Kick-out spring for rapid, positive operation
Simplicity of design for longer life

The relay's compact design saves critical mounting area, whether in multiple-unit panels, in combination enclosures or singly in machinery.

Contacts may be easily converted from Normally Open to Normally Closed in the field.

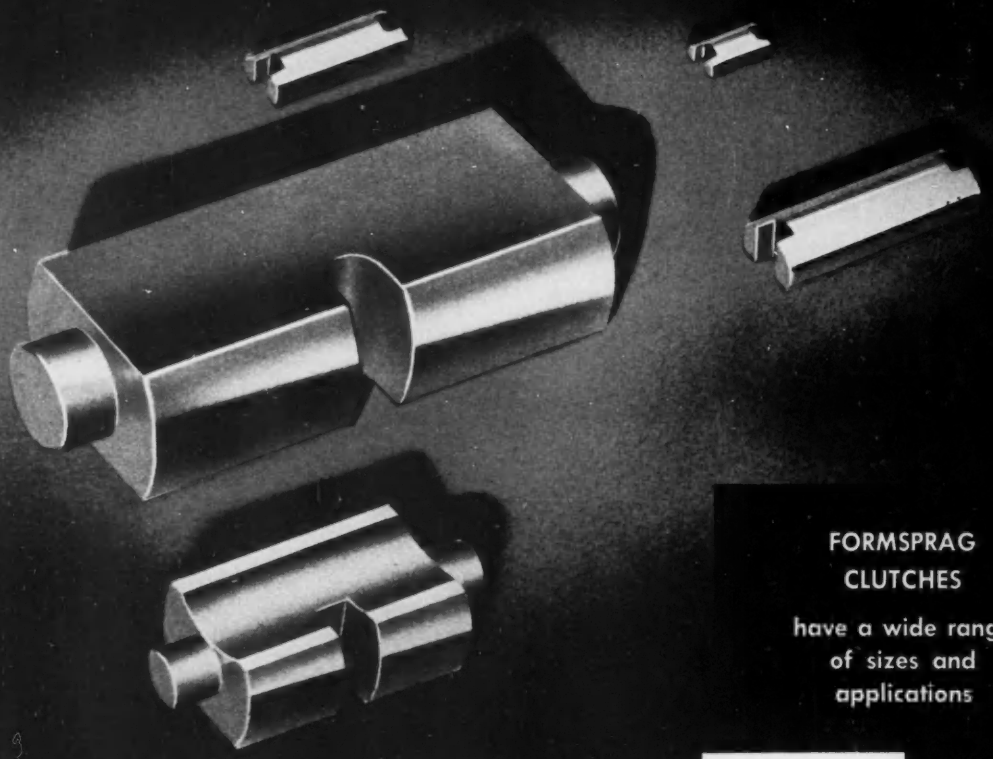
The Type N Relay is rated 10 amperes (open), and is available in any pole combination up to 6 poles; can be supplied for any voltage up to 600 volts a-c and either open or in standard NEMA enclosures.

Westinghouse offers you a full line of control to handle competently the simplest or most complex control requirements.

Let us work with you. Call your Westinghouse Representative or write for B-5817. Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. J-30130

YOU CAN BE SURE...IF IT'S
Westinghouse
Life-Line CONTROL

FORMSPRAG *Full Complement*



FORMSPRAG CLUTCHES have a wide range of sizes and applications

Smallest Formsprags are used in DITTO office machines

Backstop in DODGE MFG. CORP. Speed Reducers

In the feed mechanism of Diebel DI-MATIC Presses

In PACKARD'S famous Ultramatic Transmission

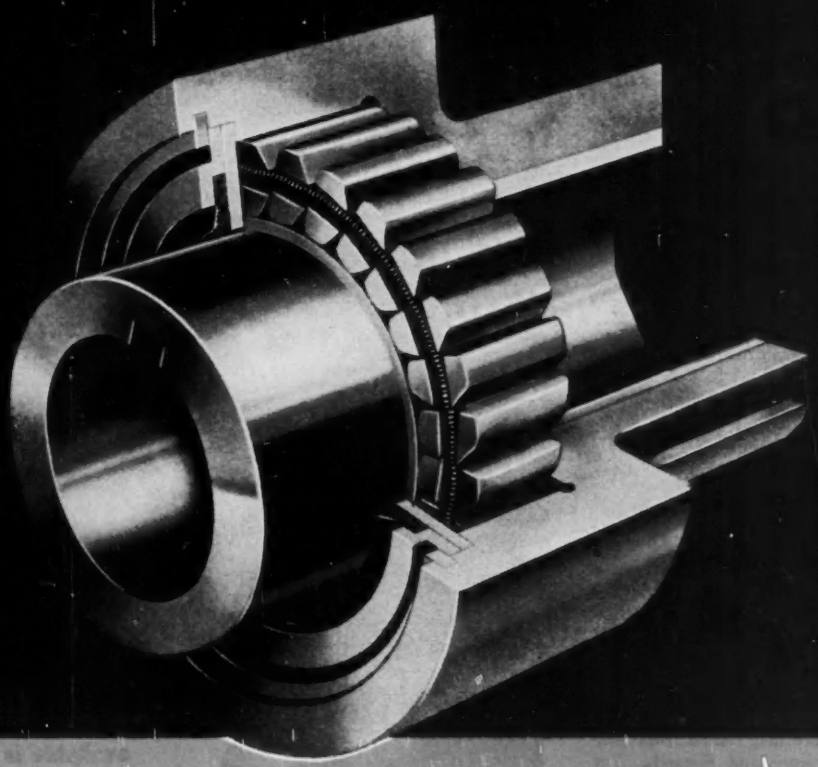
Largest Formsprags are in clutches for oil well rigs

MANY STANDARD SIZES STOCKED BY DISTRIBUTORS IN PRINCIPAL CITIES

SPRAGS USED IN FORMSPRAG OVER-RUNNING, INDEXING AND BACK-STOPPING CLUTCHES

WHAT THEY ARE: Originally sprags were simply pieces of wood used to keep a wagon wheel from rolling backward down an incline. **HOW THEY ARE MADE:** Sprags are made of hardened alloy steel formed to scientifically-determined and time-tested contours. Shown above are five standard sizes. **WHAT THEY DO:** When assembled in full complement in a Formsprag clutch, they grip at an infinite number of positions without backlash.

Over-Running CLUTCHES



Greatest Possible Torque Capacity for Size and Weight

The Formsprag Clutch consists of cylindrical inner and outer members completely filled with spring-energized sprags. It's a full complement clutch. Torque is delivered through many points of contact. Once the torque is removed, the sprags release — instantaneously.

FORMSPRAG DESIGN IS SIMPLE.
There are only four basic parts:

1. **Outer housing**
2. **Inner race**
3. **Full complement of sprags**
4. **Energizing springs.**

Before you specify another clutch, be sure to read this folder!

FORMSPRAG
Company

Designs are available for Balansprag and Cagedsprag Over-Running Clutches

23607 HOOVER ROAD, VAN DYKE (Detroit), MICHIGAN

FORMSPRAG:
Send the folder to:

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

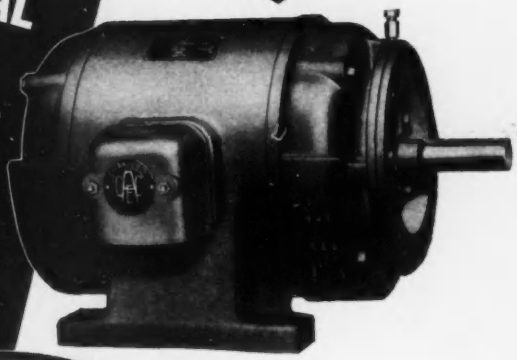
For lower pumping cost per gallon...

choose ACEC VERTICAL and HORIZONTAL PUMP MOTORS

1 hp. to 75 hp. —all available from stock

VERTICAL HOLLOW SHAFT MOTORS
Squirrel Cage—3-phase—Drip Proof—High Thrust—Standard Reverse Protection Clutch—3 to 75 hp. (larger sizes built to order)

TYPE C FACE MOUNTED MOTORS
Squirrel Cage—3-phase—Drip Proof—900 to 3600 rpm—¾ to 50 hp. (larger sizes built to order). Standard or Long Shaft Extension.



TYPE P VERTICAL SOLID SHAFT MOTORS
Squirrel Cage—3-phase—Drip Proof—High Thrust. 900 to 3600 rpm—¾ to 25 hp. (larger sizes built to order)

For dependable operation at a lower cost per gallon, team your pumps with ACEC pump motors. Produced by the WORLD'S FOURTH LARGEST Electrical Manufacturer, ACEC pump motors offer the electrical and mechanical excellence that results from over 70 years of experience and research. Yet they're priced *below* most other motors.

Manufactured strictly to NEMA FRAMES AND SPECIFICATIONS, ACEC motors are available *from stock* in branches and warehouses located in New York, Chicago, Kansas City, New Orleans, Houston, and Los Angeles. And a nation-wide network of 232 DISTRIBUTORS AND SERVICE SHOPS assures prompt and efficient servicing.

For top-level motor performance and utmost motor dependability *at lower prices*, contact our main office and we will have our nearest representative call you.

ALL ACEC MOTORS FULLY GUARANTEED

available in the following types:

- ★ **Open Drip Proof** (Fhp. and Integral)
- ★ **T.E.F.C.** (Fhp. and Integral)
- ★ **T.E.N.V.** (Fhp.)
- ★ **Pump Motors**
  Style "C" Face Mounted
  Style "P" Vertical Solid Shaft
  Vertical Hollow Shaft
- ★ **Industrial Sewing Machine Clutch Motors**
- ★ **Geared Motors and Capstans**

ACEC CHARLEROI Motors

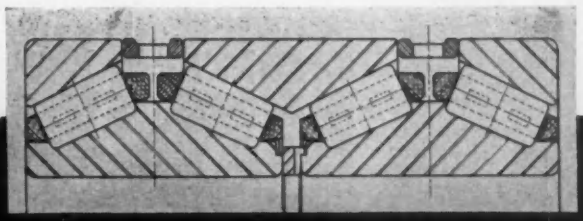
BELGIAN ELECTRIC SALES CORPORATION

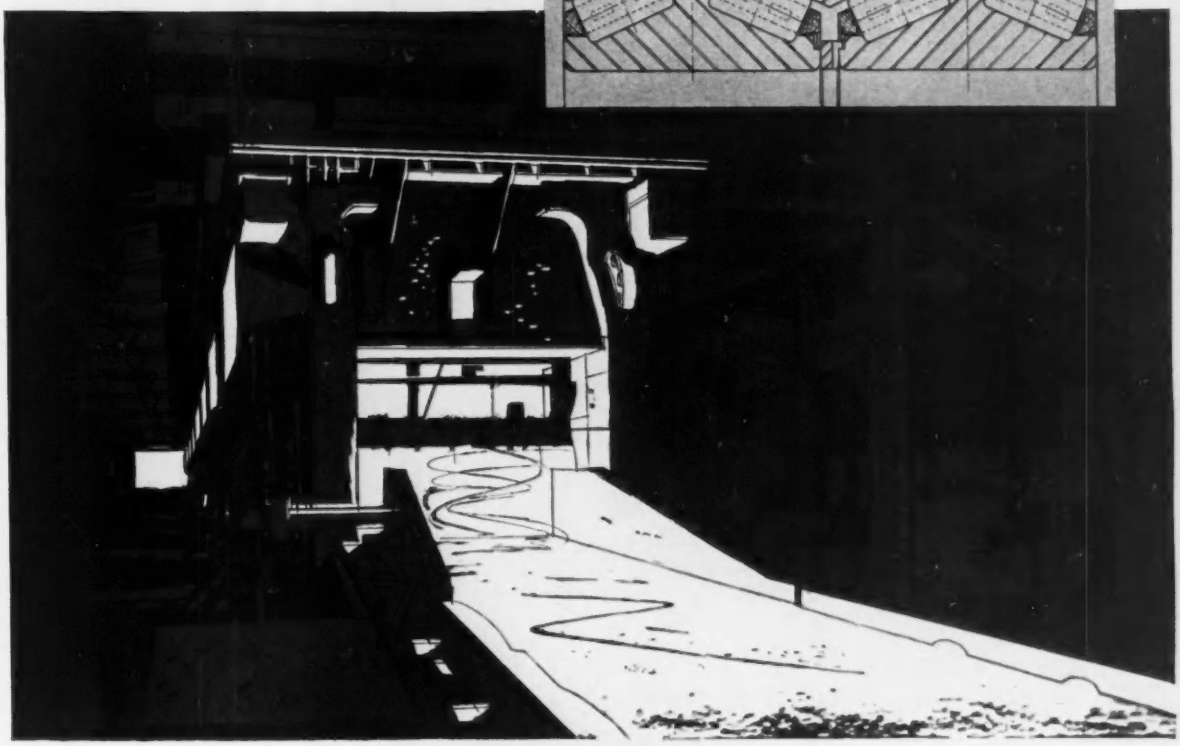
Main Office: One E. 53rd St., New York 22, N. Y. • PLaza 8-3105

Branches and Agencies

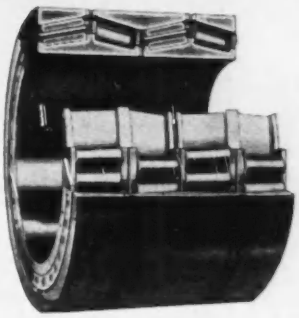
Los Angeles • San Francisco • Chicago • Kansas City
Detroit • Milwaukee • Cleveland • Houston • New Orleans • Orlando
Savannah • Montreal • San Juan (Puerto Rico) • Mexico City

TORRINGTON Four-Row Tapered Roller Bearings on finishing-stand work-rolls of U. S. Steel 80" hot-strip mill were specially designed for high thrust loads.





Rolling to a new



world's record!

2,621,500 net tons of 2000-foot coils of uniform strip! That was the world's record rolled in 1951 by U. S. Steel's 80" hot-strip mill—on TORRINGTON Tapered Roller Bearings.

Precision-ground TORRINGTON Tapered Roller Bearings are used on many of the work-roll and back-up thrust positions, from the huge mill's No. 1 scale breaker to its finishing stands.

These TORRINGTON Bearings, say U. S. Steel engineers, have given excellent service. Specially designed by TORRINGTON to withstand the high thrust loads developed, they have helped to cut down-time to only one hour a turn.

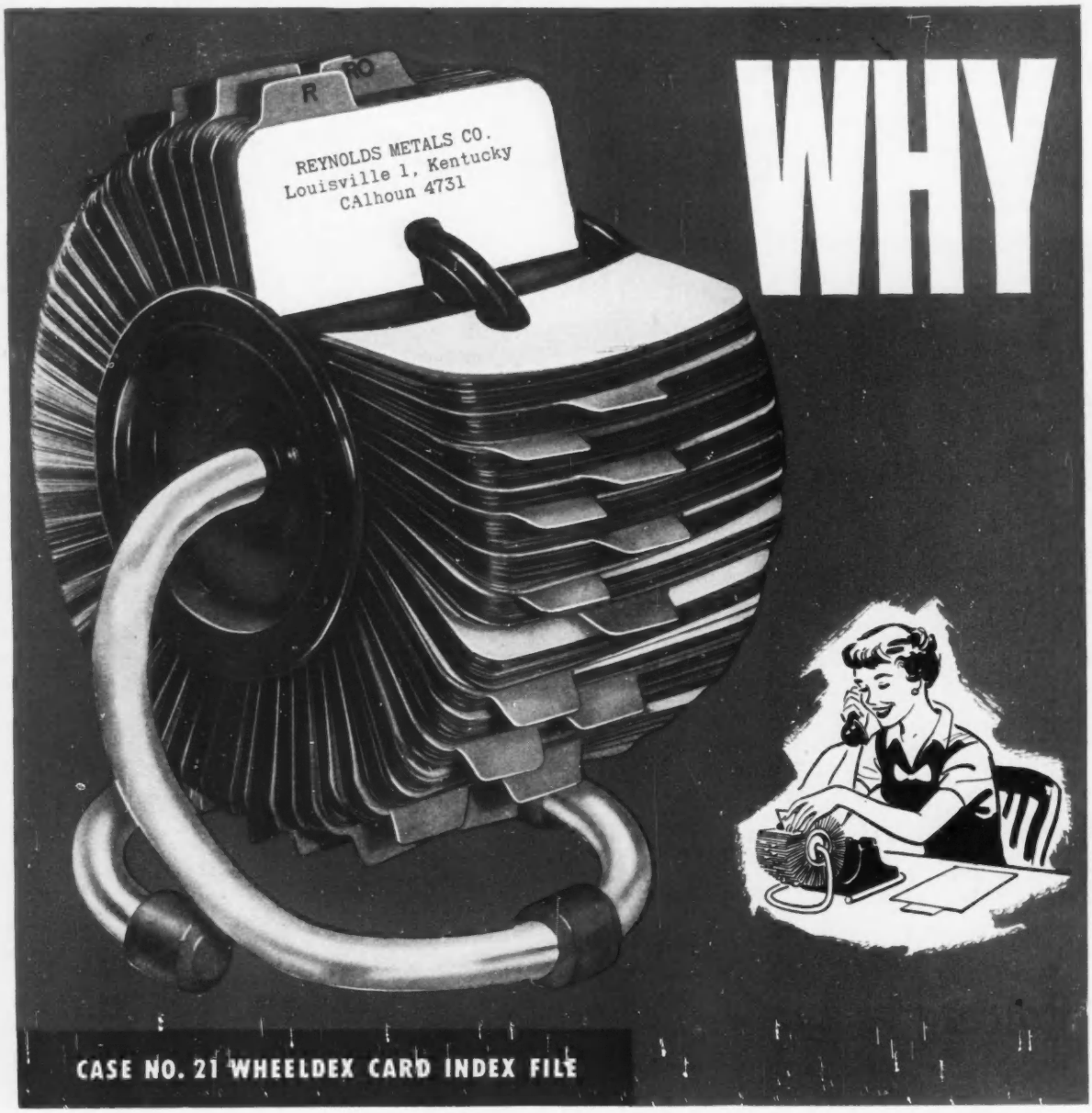
Get more tons per turn from *your* mills. Equip them with TORRINGTON Tapered Roller Bearings.

THE TORRINGTON COMPANY

South Bend 21, Ind. Torrington, Conn.

TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers



A switch to aluminum tubing *slashed 60% from the cost* of the base for this Wheeldex "Circle Base Cub" card index file.

Another metal was formerly used in this Wheeldex model. Approximately 2,000 pounds made only 3,000 bases. A wise switch to aluminum and now—2,000 pounds makes 9,000 bases, *3 times as many!*

Thus aluminum greatly reduces raw material cost per base unit. Furthermore, the former metal required buffing and chrome plating. By anodizing aluminum after a bright dip, these time-consuming, cost-building plating operations are completely eliminated! Sales figures show the beautiful anodized aluminum finish is proving highly effective in increasing eye-appeal and buy-appeal . . . and at a much lower cost! Add to these benefits, the fact that aluminum tubing is easier to form and you have another important "plus" for aluminum.

This proof of performance with aluminum as illustrated in the progressive design thinking of Wheeldex Manufacturing Company, White Plains, New York, may suggest a similar conversion from other material to aluminum in your operation. Dollar savings plus high corrosion resistance, bright, long-lasting finishes are yours with aluminum.

LET ALUMINUM SERVE YOU, TOO

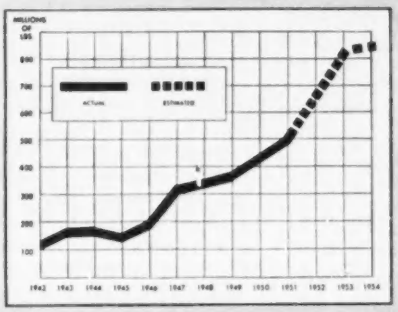
ALUMINUM?

...because it has an ideal combination of advantages found in no other metal!

More aluminum is being specified in designs today because aluminum improves products and increases sales. Let Reynolds Aluminum Specialists help your designers and engineers get maximum benefits from this modern metal. Remember, only aluminum gives you . . .

- ★ **Lightweight with great strength**
- ★ **Consistently low cost**
  no more now than before World War II
- ★ **Natural resistance to rust and corrosion**
- ★ **Attractive appearance**
- ★ **Ease of fabrication by modern methods**

STILL MORE ALUMINUM COMING



The expanding primary aluminum production of Reynolds Metals Company . . . a historic chapter in the company's 33 years of continuing growth. And primary supplies of aluminum ore will be ample for generations.

To the man in charge of production

Acquaint yourself with accepted techniques for fabricating aluminum. Write on your letterhead for aluminum fabrication books listed at right. On special problems consult with Reynolds staff of aluminum specialists. Reynolds Metals Company, 2561 South Third Street, Louisville 1, Kentucky.

Yours For The Asking . . .
REYNOLDS TECHNICAL BOOKS

(please request on business letterhead)*

- Aluminum Data Book
  (Aluminum Alloys and Mill Products)
- Aluminum Structural Design
- Designing with Aluminum Extrusions
- Fastening Methods for Aluminum
- Finishes for Aluminum
- Forming Aluminum
- Heat Treating Aluminum Alloys
- Machining Aluminum Alloys
- Welding Aluminum
- Metals Weight Slide Rule

Complete index of all technical literature and films on aluminum design and fabrication also available.

**Instructors in technical schools are also invited to take advantage of these educational aids.*

Be sure to see "Mister Peepers" every Sunday night, 7:30 EST, NBC-TV; hear "Fibber McGee and Molly" every Tuesday night, 9:30 EST & PST, NBC.

REYNOLDS ALUMINUM

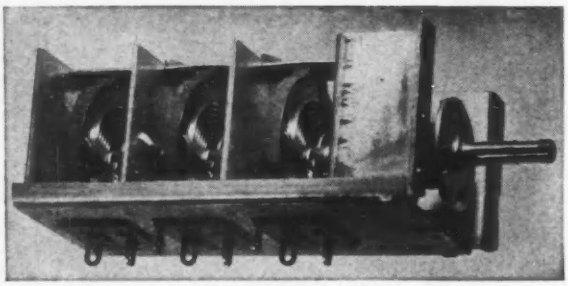
REYNOLDS METALS

MODERN DESIGN HAS ALUMINUM IN MIND

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



VHF Inductuner, courtesy P. R. Mallory & Co., Inc., Indianapolis, Indiana.

Designers of Electronic Components Prefer Copper Alloys

The complexity of modern radio and television equipment has radically affected the design of component parts. The electronic parts manufacturer, through careful design and choice of materials, is continually seeking methods for reducing the size and cost of his parts and to improve their quality.

VHF Inductuner®

The illustrated, compact, highly efficient Inductuner consists of three small spiral wound coils ganged together. The inductance of each is simultaneously varied by rotating a common insulated shaft. Three silver-plated brass collars are clamped to the shaft. Riveted to each is a silver-plated, movable contact arm with a grooved tip which follows the spiral of the coil, pivoting as the diameter of the coil changes. A stationary contact arm maintains constant pressure against one side of the rotating collar. This contact arm is riveted to a brass input terminal. The other input connection is made through another brass terminal which is soldered directly to the inside end of the coil.

All brass parts are silver-plated to improve conductivity and resistance to corrosion. Being non-magnetic, they do not affect the magnetic field around the coils.

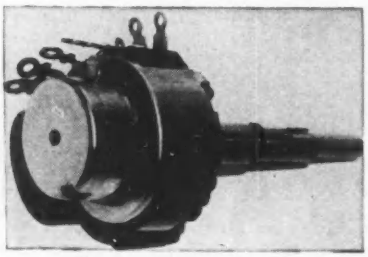
A free-cutting brass bushing, fastened to the frame, serves to guide the shaft and also acts as a spacer, positioning six metal stops. To keep the stops from separating, a brass washer, spring temper, exerts a slight pressure against them.

Brass Shaft Combines Potentiometers

Two separate circuits can be mechanically controlled by using a dual potentiometer for space saving and cost reduction. The front unit is operated by a hollow brass shaft made from free-cutting brass rod (alloy 6). The rear unit is operated by a solid shaft which passes through the hollow brass shaft. Both shafts are contained within a threaded free-cutting brass bushing which is used to fasten the dual potentiometer to the chassis.

The excellent machinability of free-cutting brass rod allows the bushing and hollow shaft to be held to close dimensions minimizing any play between the parts. At the same time, the low coefficient of friction of leaded brass prevents binding.

Within each unit a spring brass, silver-plated contact rides on a resistance strip exerting a uniform pressure as it is rotated. Any variation in conductivity due to variations in pressure, scratching of the resistance strip, or corrosion could seriously hinder the proper operation and life expectancy of the unit.

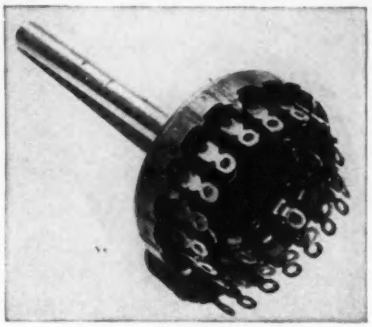


Dual Potentiometer, courtesy P. R. Mallory & Co., Inc.

Compact Rotary Switch

This 6-pole, 3-position rotary switch is compactly designed for maximum efficiency and long life. Mounted on a stationary laminated phenolic disc are 24 contacts made of Cartridge Brass (70% copper, 30% zinc), silver-plated for lower contact resistance.

Six small phosphor bronze, Grade A (95% copper, 5% tin, 0.15% phosphorus), silver-plated, movable spring contacts are located on another laminated phenolic disc which in turn is fastened to the shaft. When the shaft is rotated, the movable contacts bridge across the stationary contacts making and breaking the different circuits.



Rotary Switch, courtesy P. R. Mallory & Co., Inc.

A heavy phosphor bronze spring, fastened to the shaft, is designed to exert a constant pressure against the casing. Indentations on the casing index the shaft rotation to conform to terminal locations. A ⅜-inch threaded bushing made from free-cutting brass rod is used to mount the switch.

Copper-Base Alloys — For Highest Quality

For highly functional, longer-lasting parts, copper-base alloys offer many advantages. The slight difference in cost, if any, is infinitesimal when figured on a unit cost basis. On the other hand, false economy or incorrect choice of materials will greatly reduce the life span and jeopardize the operation of the entire unit. Our laboratory will be glad to work with fabricators to help choose the proper copper-base alloys for specific needs. (9108)

Stupakoff

Save space and weight
Speed Assembly
Reduce Costs
Minimize Assembly errors

Soldered connections are reduced by 25% to 80%, assemblies are lighter and more compact, your production time is reduced and better products are made when Stupakoff Printed Circuits are used. These sturdy, compact, accurately produced units combine resistors and capacitors of precision values, in circuits designed in accordance with the requirements of individual applications. One Stupakoff Printed Circuit will replace many individual components, with consequent simplification of the assembly and reduced costs.

Send for Bulletin

Contains complete specifications of a number of typical standard circuits and detailed information on the design and construction of Stupakoff Printed Circuits. *Ask for Bulletin 1151.*

STUPAKOFF *Products for Electrical and Electronic Applications*

ASSEMBLIES—Metallized ceramic induction coils and shafts; metallized plates for fixed rigid assemblies; ceramic trimmer condensers.

CERAMICS—Precision-made ceramic products for electrical and electronic applications, all voltages, frequencies and temperatures.

RESISTOR CERAMICS—Used for temperature indicating or measuring equipment, for infra-red light source and for heating elements. Complete with terminals, in the form of rods, tubes, discs, bars, rings, etc.

CERAMIC DIELECTRICS—For by-pass, lead-through, blocking, stand-off and trimmer applications. Temperature compensating Ceramic Dielectrics and high K materials. Tubes, discs and special shapes, plain or silvered.

STUPALITH—Will withstand extreme thermal shock. May be made to have zero, low-positive or negative expansivities. Safely used at temperatures up to 2400° F.

SEALS, KOVAR-GLASS—Terminals, Lead-ins; Stand-offs—for hermetically sealing and mechanical construction in radio, television, electronic and electrical apparatus. Single or multiple terminal units, in a wide variety of sizes and ratings.

KOVAR METAL—The ideal alloy for sealing to hard glass. Used for making hermetic attachments. Available as rod, wire, sheet, foil—or as cups, eyelets and other shapes.

STUPAKOFF CERAMIC & MFG. CO., Latrobe, Pennsylvania

Do you need . . .

CORK-AND-RUBBER GASKET MATERIALS

made to meet government specifications?

ARMSTRONG CAN SUPPLY THEM

You can get Armstrong materials made to meet every one of the eight classes of the principal government specifications covering cork-and-rubber gasket materials. These materials are listed below.

Government Specification		Armstrong Material
MIL-G-6183	Type I Soft	NC-709
	Type I Medium	NC-710
	Type I Firm	NC-711
	Type II Soft	DC-167
	Type II Medium	DC-100
	Type II Firm	DC-113
MIL-T-6841A		DK-153 or RK-304S
MIL-G-6747		DK-149

For samples and full information on these materials, call your nearest Armstrong office or see Sweet's file for product designers.

New cork-and-rubber compounds. Armstrong's Research and Development Center is ready to develop new cork-and-rubber materials as new military requirements arise. Please discuss your needs with your nearest Armstrong representative . . . or write.

Cork compositions. There's an Armstrong Cork Composition for each of the classes under Federal Specification HH-C-576, as well as each of the grades under Specification MIL-C-16090.

Synthetic rubber compounds. Armstrong makes specialized synthetic rubber compounds for critical uses. If you need an out-of-the-ordinary rubber compound, please discuss your requirements with your Armstrong representative.

Send for this helpful gasket manual

New '53 Edition

You'll find up-to-date information on current government specifications and tentative SAE-ASTM specifications in "Armstrong's Gasket Materials."

You'll find, too, in this 24-page manual, a lot of helpful information on the design and use of gaskets. Included are discussions of subjects such as designing gaskets to reduce cost . . . practical tolerances for resilient gaskets . . . designing flanges for efficient sealing, and many others.

See "Armstrong's Gasket Materials" in Sweet's file for product designers. For a personal copy of this manual, write to Armstrong Cork Co., Gaskets and Packings Dept., 7102 Arch St., Lancaster, Pa.

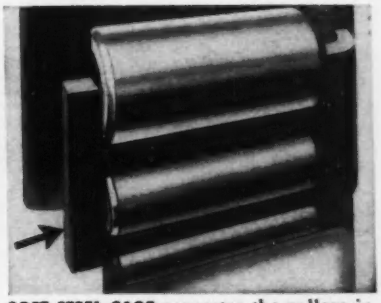
ARMSTRONG'S GASKET MATERIALS

Your nearest Armstrong Industrial Division office

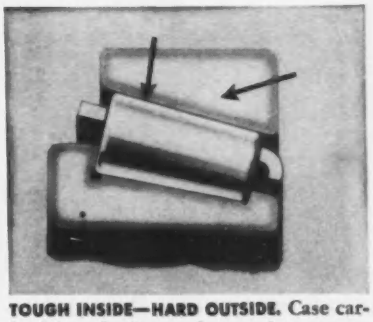
ALBANY 10, N. Y., 268 Spruce St. at Northern Boulevard, Telephone: 4-0131 • BOSTON 16, MASS., 131 Clarendon Street, Telephone: COpley 7-2490 • CHICAGO 54, ILL., 13-136 The Merchandise Mart, Telephone: DElaware 7-0500 • CINCINNATI 2, OHIO, 301 Temple Bar Building, Telephone: PArkway 3220 • CLEVELAND 15, OHIO, 209 Hanna Bldg. Annex, Prospect Ave. and E. 14th Street, Telephone: MAin 1-7900 • DETROIT 26, MICH., 10th Floor, Free Press Building, 321 Lafayette Avenue, West, Telephone: WOodward 3-5670 • GREENVILLE, S. C., 33 Norwood Place, Telephone: Greenville 3-5302 • LOS ANGELES 15, CALIF., 719 Bendix Building, 1206 Maple Avenue, Telephone: RICHmond 0286 • NEW YORK 16, N. Y., 295 Fifth Avenue, Telephone: MUrray Hill 4-6900 • PHILADELPHIA 2, PA., Robinson Building, Fifteenth and Chestnut Streets, Telephone: LOcust 4-4290 • ST. LOUIS 3, MO., 1205 Olive Street, Telephone: CHestnut 1757 • IN CANADA: Armstrong Cork Canada Limited, 6911 Decarie Boulevard, Montreal, Quebec, Telephone: ATlantic 4733.

9 good reasons for specifying TIMKEN® tapered roller bearings

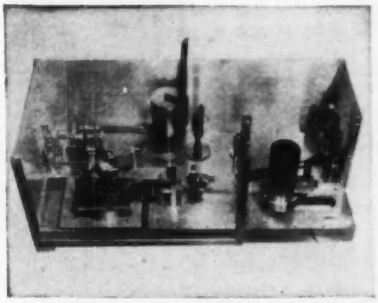
26 TYPES. Because Timken® bearings are made in 26 types, you get exactly the right tapered roller bearing for your job.



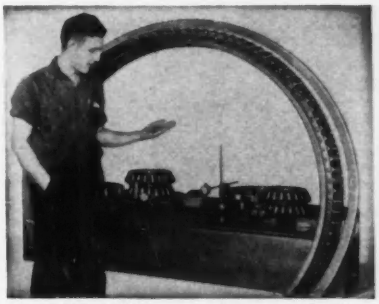
SOFT STEEL CAGE separates the rollers in Timken tapered roller bearings and prevents scuffing.



TOUGH INSIDE—HARD OUTSIDE. Case carburizing of rollers and races gives a wear-resistant surface, shock-resistant core.

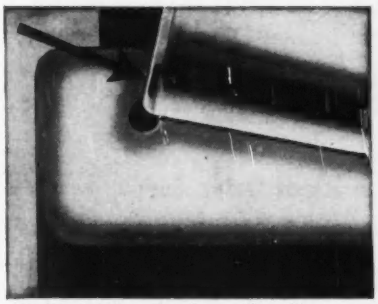


MICRO-INCH FINISH. With help of the profilograph, which measures surface irregularities to a millionth of an inch, the Timken Company has developed a bearing finish of micro-inch accuracy.

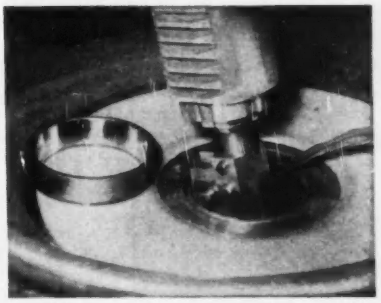


5850 SIZES. If you need a tapered roller bearing smaller around than your finger or as large as 71½" in diameter, you can get it from The Timken Roller Bearing Company.

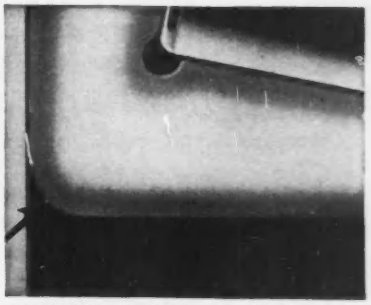
WE MAKE OUR OWN STEEL. Because Timken bearings are made of special alloy steel, produced in the Timken Company's own mills, they have extra strength and wear resistance.



RIB OF CONE maintains roller alignment, prevents skewing, assures maximum bearing capacity.



PRECISION MANUFACTURE makes possible bearings with a maximum runout tolerance of less than 75 millionths of an inch.



GENEROUS RADIUS on the inside diameter of Timken bearing cones permits greater shaft strength.

No other tapered roller bearing gives you all the advantages you get with Timken bearings. Be sure every tapered roller bearing you use carries the name "Timken", the trade-mark of The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN
TRADE-MARK REG. U.S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST ⊣◫⊢ LOADS OR ANY COMBINATION ✳

PLANNING new products?

GÝROL FLUID DRIVE can help!

Providing new products with an extra sales advantage is another of the outstanding qualities of American Blower Gýrol Fluid Drives.

WE THINK you'll agree that lowest starting current, smoother acceleration, overload protection, shock absorption and adjustable speed are desirable advantages to have on any new product.

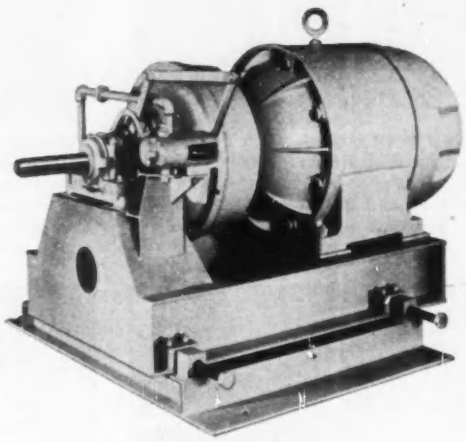
And you can have all these advantages and more on your new products by using American Blower Gýrol Fluid Drives.

With Gýrol Fluid Drives, all shocks between driving and driven machinery are absorbed in a cushion of oil. There's no metal-to-metal contact. Gýrol Fluid Drives eliminate delays, prevent damage to motors and machines.

For complete data on how American Blower Gýrol Fluid Drives can help make your new products perform better, phone the nearest American Blower Branch Office—conveniently located in principal cities.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

AMERICAN BLOWER



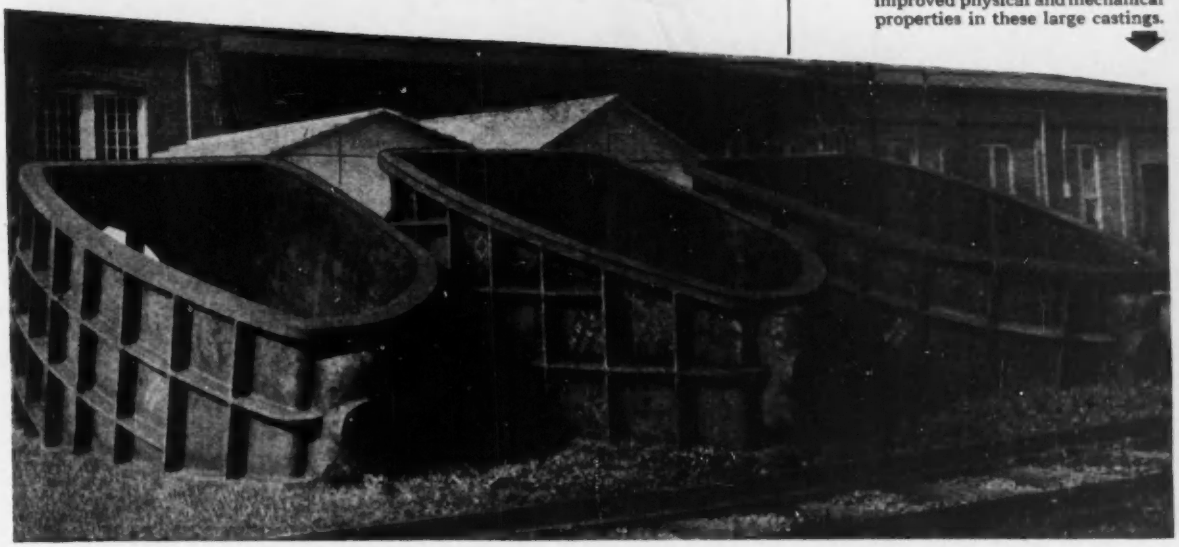
An Ideal Drive for:

Agitators	Cranes & Hoists
Blowers	Dredges
Car Dumpers	Elevators
Car Pullers	Fans
Clarifiers	Laundry Tumblers
Centrifugals	Laundry Washers
Clay Working Machinery	Machine Tools
	Mills
Compressors	Mixers
Conveyors	Pumps

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

NICKEL CAST IRON PROVIDES HIGH STRENGTH AND PRESSURE TIGHTNESS...

Water boxes produced of nickel cast iron by Kutztown Foundry & Machine Corp., for Foster Wheeler Corp., to obtain greatly improved physical and mechanical properties in these large castings.



IN CASTINGS OF LARGE DIMENSIONS

Here are three water boxes, weighing 21,500 pounds each, for a power-plant condenser system designed by Foster Wheeler Corporation, New York City.

Excessive pressures of the service involved call for high strength, as well as high density of grain structure.

Accordingly, these water boxes, produced by Kutztown Foundry & Machine Corporation, Kutztown, Pa., were cast in 2% nickel cast iron.

Meeting ASTM "Class 50" specification (minimum 50,000 psi tensile strength) and characterized by dense structure with fine dispersion of graphite throughout, this nickel cast iron provides an extraordinary degree of pressure tightness under hydrostatic pressures.

The matrix of nickel alloyed iron closely resembles the pearlitic matrix found in high-carbon steels. In contrast, the matrix of ordinary plain iron resembles that found in low-carbon steels.

Throughout industry, nickel cast irons spell economy when you need strength, wear resistance and pressure tightness. Write for our suggestions regarding the best nickel alloyed iron for your specific applications.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, nickel is obtainable for the production of engineering nickel cast irons for many end uses in defense and defense supporting industries.

The International Nickel Company, Inc.
Dept. 20, 67 Wall Street, New York 5, N. Y.

Please send me booklet entitled, "Guide to the Selection of Engineering Cast Irons."

Name_____ Title_____

Company_____

Address_____

City_____ State_____

THE INTERNATIONAL NICKEL COMPANY, INC.

The Company faced with cold forming this thread rolled depressed head machine screw said, "We just wouldn't attempt to make it from any standard grade of 18-8!"

When this Company was asked to produce a second lot of these sheet metal screws from a regular 18-8, here was the reply: "Impossible —there's too much punch breakage!"

What would *you* do

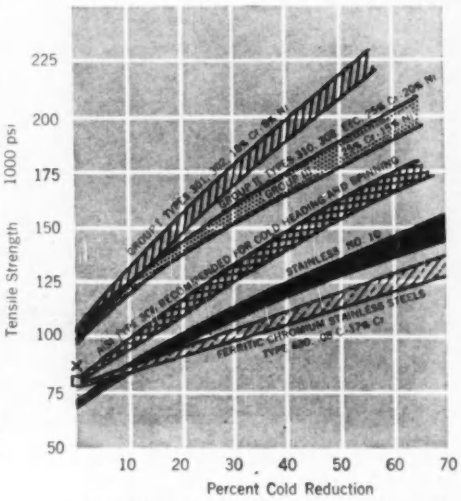
if you had to
mass produce
these fasteners
from 18-8 stainless
...without "losing your shirt"?

Both jobs were produced economically from a totally NEW chrome-nickel stainless!

Both companies successfully turned out these jobs with new Carpenter Stainless No. 10—the first chrome-nickel Stainless to permit economical, mass production of severely cold headed and upset fasteners and other parts. Carpenter No. 10 work-hardens far slower than any of the conventional 18-8 grades. That's the secret of its success. That is why it is ideal for cold headed bolts, screws, and upset nuts made on automatic machines. In fact, it is suited for any job involving heading, extrusion, severe coining and swaging. And the corrosion resistance of No. 10 is slightly better than Types 302, 304 and 305.

Of course, because of its high nickel content, Carpenter No. 10 is subject to present government regulations, and its supply is limited. Yet, we always like to keep you informed about the possibilities of a product like this. Upon request, we will be glad to give you more information about No. 10—its corrosion resistance, cold workability, machinability . . . as well as its usefulness for parts that must remain non-magnetic after severe cold working. So drop us a line on your Company letterhead, now . . . or any time. THE CARPENTER STEEL COMPANY, 117 W. BERN ST., READING, PA.

Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"



Comparison of various Stainless Steels showing increase of tensile strength with percentage of cold reduction.

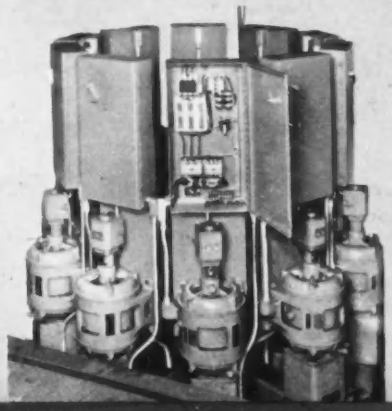
Carpenter STEEL

Stainless No. 10

takes the problems out of production

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

SPEEDYLECTRIC STEAM-JET CLEANER—a compact "RA" Starter makes possible a neat surface mount for easy access.



ALLEN TAPPER & THREADER—conveniently located panels house "RAB" Starters controlling the reversing spindles.

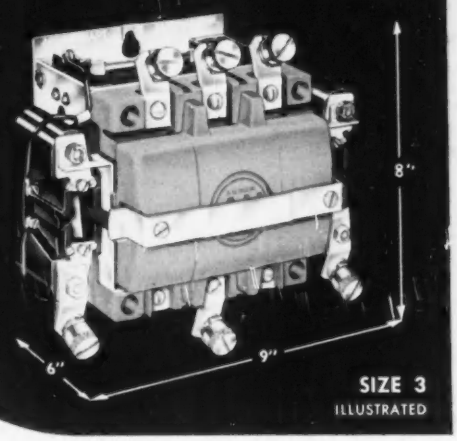
TWIN-TOOL GRINDER—A-H Controls mounted on the side are neat, convenient to the operator, easily accessible.

ARROW AH HART

ARROW-HART MOTOR STARTERS AND CONTACTORS

Serve Better and Longer

WITH MORE OUTSTANDING FEATURES



SIZE 3
ILLUSTRATED

JUST ½ THE SIZE and WEIGHT

— permits smaller control panels and cavities, better layout.

EASY INSTALLATION

— straight-thru wiring saves **30%** time and work, circuits are easier to identify.

EASY MAINTENANCE

— front-wired terminals . . . contacts readily accessible.

MORE EFFICIENT

— exclusive knee-action, bellcrank fulcrum mechanism multiplies leverage, increases contact pressure, takes less space.

GREATER ARC RESISTANCE

— by **55%** with alkyd type base and hood . . . individual arcing chambers.

HEAVY-DUTY CONTACTS

— positively aligned. Vertical operating position — sheds breakdown materials.

Better service is ***built into*** A-H Motor Controls. Not with just minor improvements, but through a new concept of motor control design . . . exclusive with Arrow-Hart. A functionally simple design, it skillfully balances all components for greatly increased efficiency. It's years ahead in providing dependable operation, maximum rated performance and long life. These outstanding advantages are available today as replacements for obsolete design or for improved product design of original equipment. Take the first step — buy a Type "RA" Motor Starter or Contactor, and compare it with the conventional type of controls.

SIZES AND TYPES ON THE REVERSE SIDE.

BUY WITH CONFIDENCE • PROFIT BY PERFORMANCE

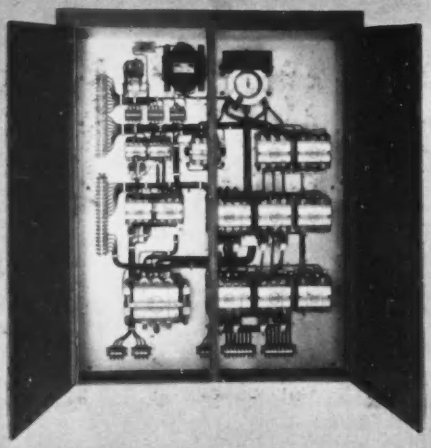
THE ARROW-HART & HEGEMAN ELECTRIC CO., HARTFORD, CONN., U.S.A.

ELECTRICAL CONTROLS

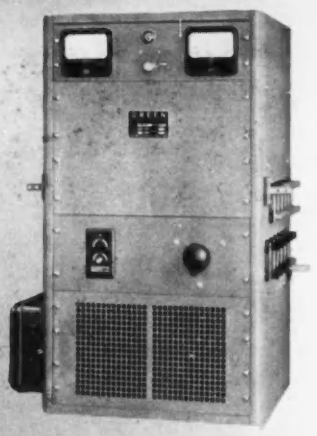
ARROW AH HART

ESTABLISHED IN 1890

MALSBARY STEAM CLEANER — the much smaller "RA" Starter leaves more room for other components.



BATH CONTOUR FORMER CONTROLS — a panel just 36" x 44" x 16" holds 2 Size 00 and 2 Size 3 Contactors, a Size 2 and a Size 4 Starter, a Size 1 and a Size 2 Reversing Starter, 2 Size 2 Two-Speed Starters and a Size 3 Reversing Contactor.



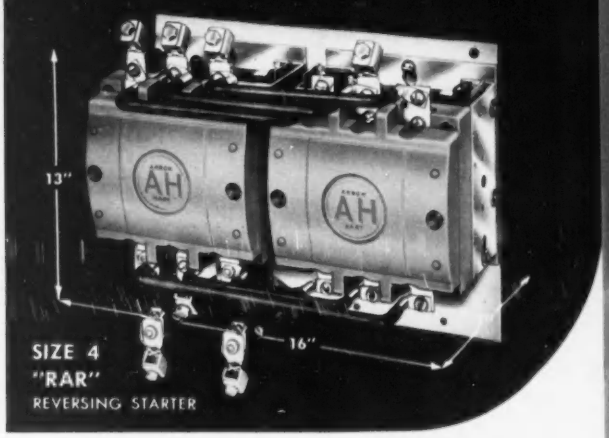
GREEN MULTI-RECTIFIER — dependable control is assured by a "CRA" Contactor and A-H Push Buttons.

More and More PROGRESSIVE Companies are buying ARROW-HART MOTOR CONTROLS

ARROW AH HART

A Complete Line

Type "RA" Starters are supplied in sizes 0, 1, 2, 3, 4 and 5, including "RAR" and "RAS" Reversing and Two-Speed Starters, "RAC" Combination Starters, and "RCAR" Combination Reversing and "RCAS" Two-Speed Starters. There's a full range of NEMA enclosures for general service and for hazardous and exposed locations, including EXPLO-SAFE explosion and weatherproof housings. Type "CRA" Contactors are supplied in sizes 00, 0, 1, 2, 3, 4 and 5, including "RARC" Reversing Contactors.



SIZE 4
"RAR"
REVERSING STARTER

You'll find ratings, dimensions, weights and complete engineering data in the Arrow-Hart Catalog: INDUSTRIAL MOTOR CONTROLS. To receive your copy, just fill in and mail the coupon below.

INDUSTRIAL CONTROL DIVISION
THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET, HARTFORD 6, CONN.

Please send my copy of the new catalog:

CO. NAME_____

MY NAME_____

POSITION_____

CO. ADDRESS_____

CITY_____ ZONE_____ STATE_____

ARROW-HART

INDUSTRIAL CONTROL DIVISION
103 HAWTHORN STREET
HARTFORD 6, CONN., U.S.A.

Offices, Sales Engineers and Warehouses in: ATLANTA, BOSTON, BUFFALO, CHARLOTTE, CHICAGO, CINCINNATI, CLEVELAND, DALLAS, DETROIT, HOUSTON, INDIANAPOLIS, KANSAS CITY MO., LOS ANGELES, MILWAUKEE, MINNEAPOLIS, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, SAN FRANCISCO, SYRACUSE.

Also Sales Engineers in Columbus Ohio, Fayetteville New York, Manchester Ct., Seattle, Springfield Mass. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

STANDARDIZE YOUR LINE YET DIVERSIFY PRODUCTS

How to simplify, cut costs—and still get product versatility... with plastics

Like many manufacturers in a profits squeeze today, you may be looking for more efficient, less costly production methods—that won't sacrifice the product *flexibility* you need to meet demands of market development, and competition.

Probably the most obvious answer lies in the economical special surface treatments that are possible with molded plastic products. With plastics, you can standardize on one or two models, yet diversify them with an almost unlimited range of functional and decorative surface effects.

For instance, radio housings (or housings for small appliances, office equipment, etc.)—molded in three dimensions of versatile Lustrex styrene plastic—can be standardized in size and shape, yet gain functional and decorative variety through several colors and a few simple surface treatments.

You'll want Monsanto's new management report that explains the advantages of lacquering, printing, metallizing, hot stamping, silk screening, and other decorating techniques for plastics. Just published, this study is available to you without cost. Just use the handy coupon.

FREE—Report to Design Engineers "How to Diversify Product Lines with Special Decorative Treatments."

MONSANTO CHEMICALS AND PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division
Room 2126, Springfield 2, Mass.

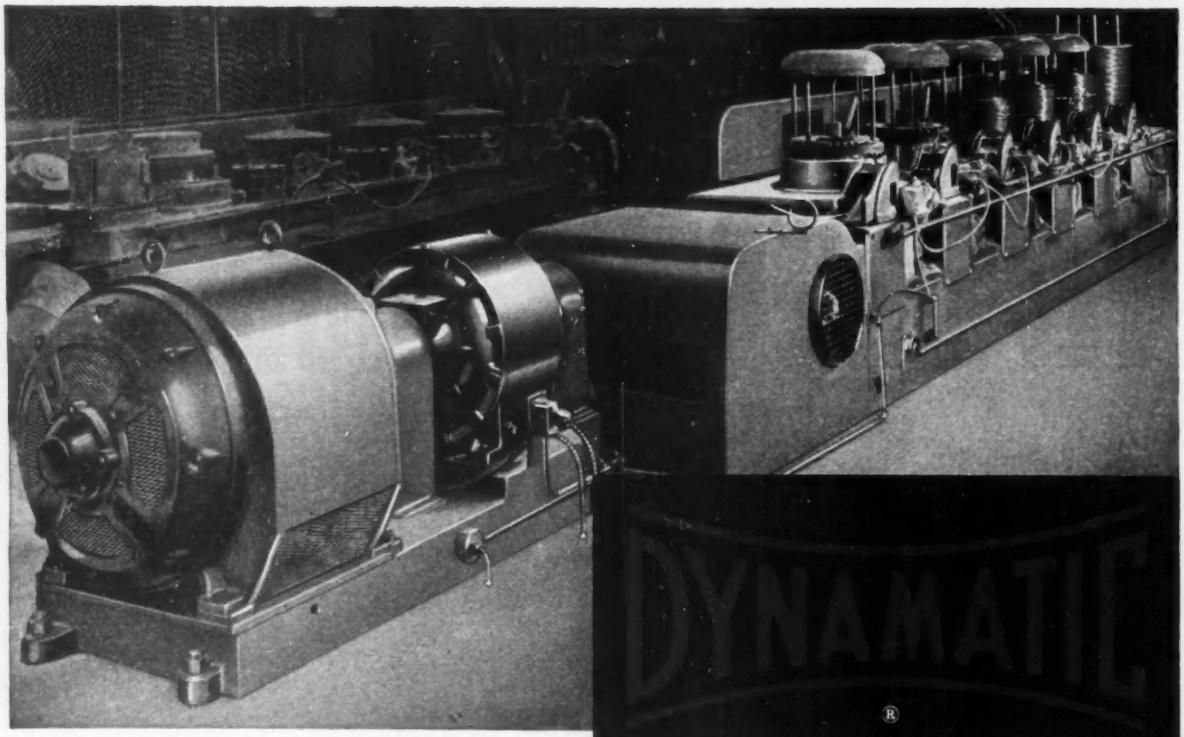
Please send me your report: "How to Diversify Product Lines with Special Decorative Treatments."

Name & Title _____

Company _____

Address _____

City, Zone, State _____



Model 7W Dynamatic Water-Cooled Coupling driving a wire machine which draws 7/32" wire to .070" in six dies. Power is derived from a 200 HP, 1200 RPM induction motor.

DYNAMATIC®

WATER-COOLED POWER COUPLINGS

Adjustable Speed Drives for Industrial Use

Dynamatic Water-Cooled Couplings provide adjustable speed drive direct from an AC power source for a wide range of industrial applications. They transmit rotation from a driving to a driven member without mechanical contact with stepless adjustable control and almost instantaneous response. A simple method of providing adjustable speed from a constant speed source (or vice versa) with full torque starts.

Effective water-in-the-gap cooling permits large capacity in small space; design provides complete protection against atmospheric impurities.

Standard sizes are available for transmitting torques of 50 pounds feet to approximately 5,000 pounds feet. Units up to 200,000 pounds feet or larger can be built to order.

Write for Illustrated Booklet WC-1

WIDE SPEED RANGE

INSTANTANEOUS RESPONSE

ACCURATE SPEED CONTROL

STEPLESS SPEED ADJUSTMENT

SMOOTH TORQUE TRANSMISSION

TOTALLY ENCLOSED

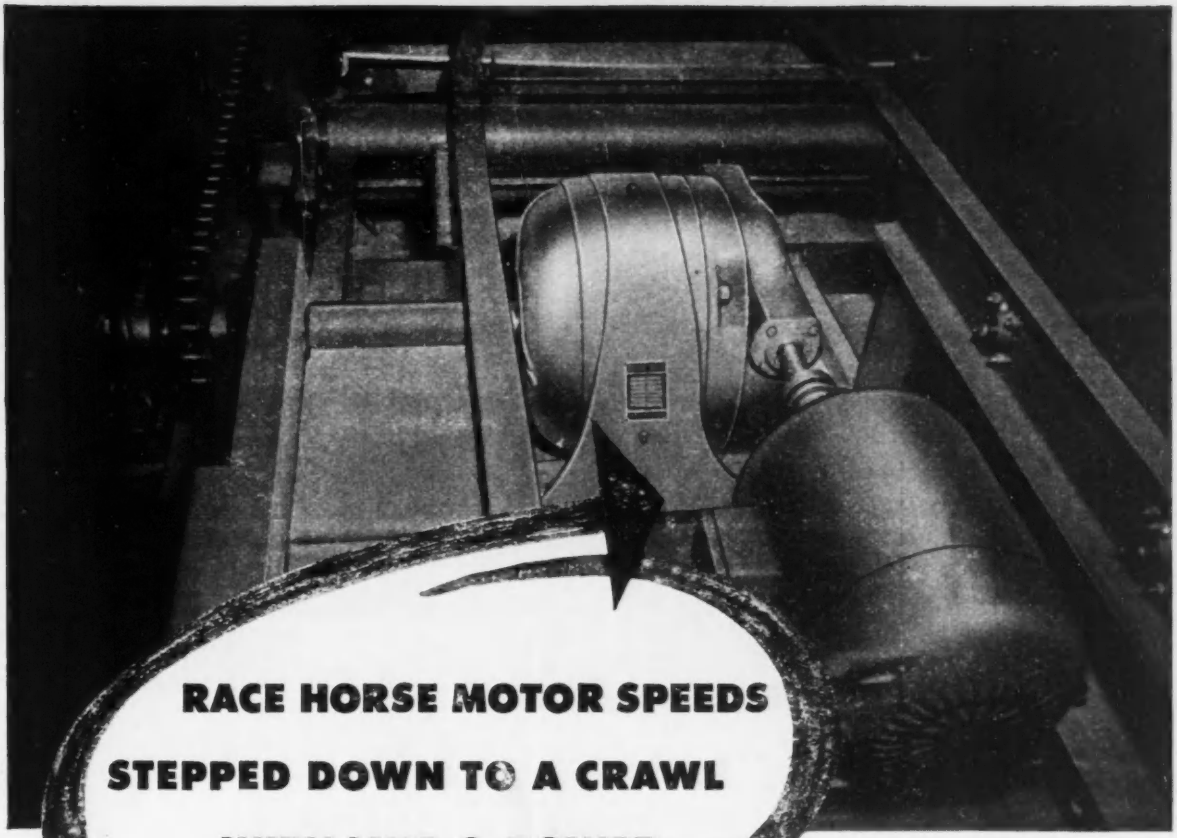
SIMPLE • QUIET

COMPACT • EFFICIENT

DYNAMATIC® **CORPORATION** • **KENOSHA WISCONSIN**

Subsidiary of **EATON MANUFACTURING COMPANY,** Cleveland, Ohio

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls



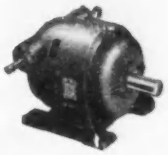
RACE HORSE MOTOR SPEEDS STEPPED DOWN TO A CRAWL WITH LINE-O-POWER

24WL Right angle Line-O-Power Drive on a Chain Conveyor

Double reduction straight line drive

Triple reduction straight line drive

Double reduction vertical drive



Double reduction right angle drive

On conveyors or other materials-handling equipment, slow speed is essential. With Line-O-Power Drives, it is possible to transform high motor speeds into almost any desired slow end speed.

Here, for example, is a compact Line-O-Power Drive on a chain conveyor. Low in original cost, it provides economical service day in and day out with minimum attention. These drives have proved their value to industry because of their compact size, sturdy construction and high efficiency.

First reduction is taken through precision worm gearing, second and third reductions through Duti-Rated helical gearing. Duti-Rated Gears have file-hard tooth surfaces with ductile cores that permit heavy loading and yet assure long life. Available for straight line service — for right angle service — or for vertical application.

FOOTE BROS.

Better Power Transmission Through Better Gears

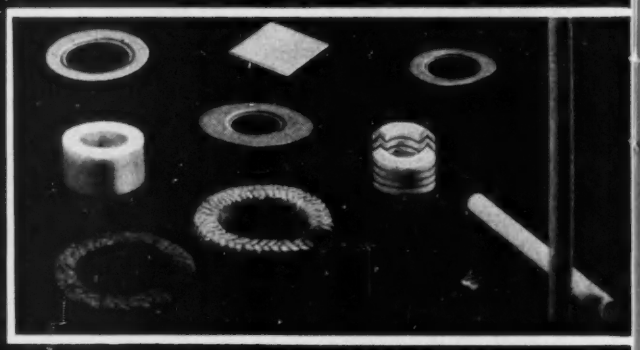
FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

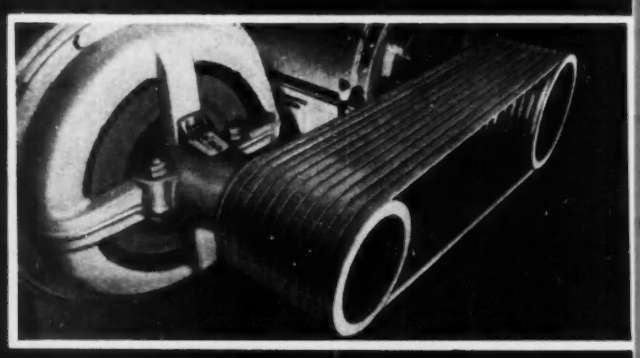
FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. W, 4545 South Western Boulevard, Chicago 9, Illinois
Please send me Bulletin LPB on Line-O-Power Drive.
I am interested in
☐ Straight line drive ☐ Vertical drive ☐ Right angle drive

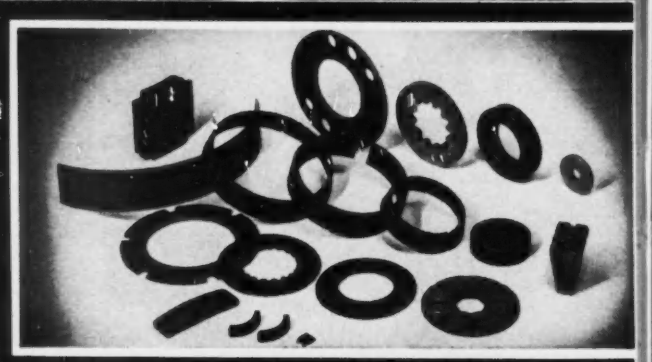
Name.....
Company.....
Position.....
Address.....
City..... Zone..... State.....

RM

Design people find Raybestos-Manhattan engineering service helpful on problems involving Asbestos, Rubber, Sintered Metal and Teflon* Products







Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packing and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

Rubber Lined and Covered Equipment

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL

To better serve you PROMPTLY.. So that R/M sales, research and engineering can best coordinate to handle your problems . . . and so that we can serve you with least delay . . . please wire, phone or write the division listed under the product in which you are interested.

PACKINGS, GASKETS

ASBESTOS TEXTILES AND TEFLON PRODUCTS

Raybestos-Manhattan makes a broad line of Teflon packings and gaskets for use with chemicals. Teflon products are practically inert chemically and will not react with strong acids or caustics. R/M is also ready to meet your specifications for Teflon rods, sheets, tubes, tape and specially fabricated parts. The highly diversified R/M line includes packings for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. R/M is also the manufacturer of an extensive line of asbestos textiles.

**Du Pont trade-mark for its tetrafluoroethylene resin*

PACKINGS, GASKETS, ASBESTOS TEXTILES AND TEFLON PRODUCTS

Packing Division or
Asbestos Textile Division
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

MECHANICAL RUBBER PRODUCTS

Smooth running is a most important feature to the design engineer where V-belts enter the problem. Condor V-Belts are the "Smoothest Running V-Belts Made," because R/M engineers microposition the strength member and design every part to run in perfect balance. Straight sidewall design means more grip, less slip, longer life. Condor V-Belts are also destretched during manufacture for minimum inelastic stretch on the drive. The result is longer trouble-free service. Also types for oil- and heat-resistance and nonspark. R/M engineers apply equal engineering ingenuity to hose, transmission and conveyor belt, and molded rubber products. R/M rubber specialists will cheerfully work with you on design problems.

MECHANICAL RUBBER PRODUCTS

Manhattan Rubber Division
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

FRICTION MATERIALS

Whatever the application . . . from giant clutch facings for heavy road-building equipment to automotive brake linings and tiny friction parts for office machinery . . . you can count on Raybestos-Manhattan friction materials for successful solutions to the Stop-and-Go problem. The segments, cones and special shapes here illustrated are typical of the wide range of R/M friction products available to meet the needs of design engineers. The R/M line, precision-made by the world's largest manufacturer of friction materials, includes both woven and molded asbestos parts and sintered metal products.

FRICTION MATERIALS

Equipment Sales Division
Raybestos-Manhattan, Inc.
445 Lake Shore Drive
Chicago 11, Ill.
Superior 7-5126

RAYBESTOS-MANHATTAN, INC.

Rubber Covered Rolls

Sintered Metal Friction Elements

Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

AND TEFLON PRODUCTS

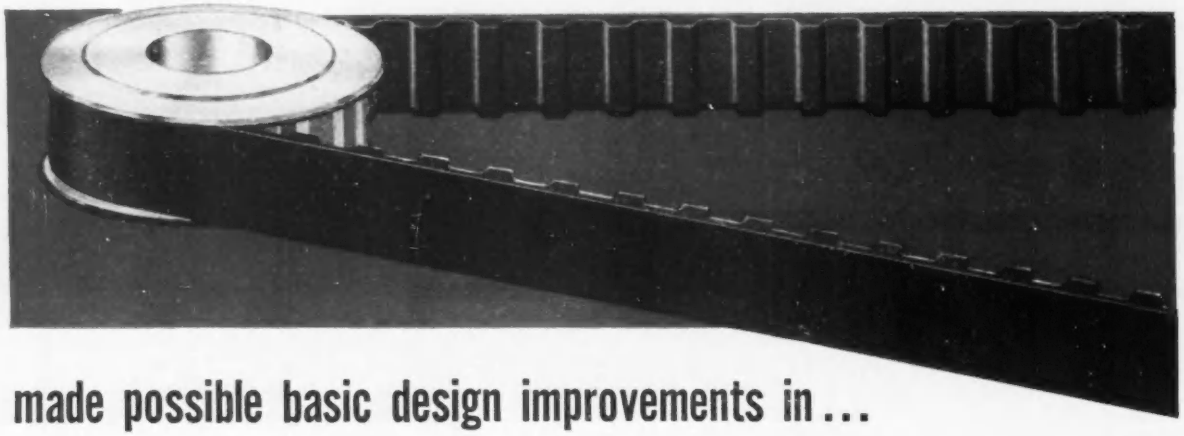
FACTORIES: Passaic, N.J. • Manheim, Pa. • Bridgeport, Conn. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

Manufacturers of Mechanical Rubber Products • Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products • Fan Belts • Radiator Hose • Rubber Covered Equipment • Asbestos Textiles • Teflon Products Packings • Abrasive and Diamond Wheels • Bowling Balls

R/M

Here's How the Revolutionary

Gilmer "TIMING"®



made possible basic design improvements in...

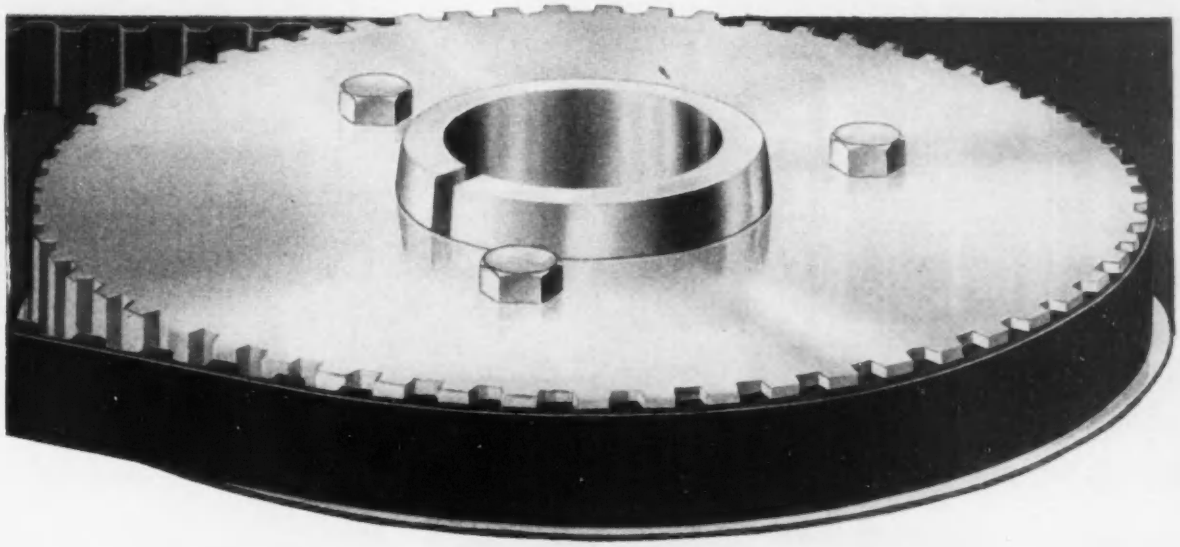
DE LAVAL 600 SERIES SEPARATORS

● Radically new, both in appearance and engineering, are the De Laval "600 Series" Cream Separators. Key to their modern functional lines and more efficient performance is the Gilmer "Timing" Belt Drive.

Replacing the former worm gear spindle drive, the "Timing" Belt Drive makes it possible to mount the motor internally, obtain almost silent operation and eliminate all drive lubrication and maintenance. By using permanently lubricated motors and sealed bearings with "Timing" Belt Drives, De Laval is able to offer dairymen a line of separators that are factory-lubricated for life! Once set up, they require no further attention.

The 4.72-to-1 step-up drive consists of a ¾-inch wide "Timing" Belt driven by a 6.5-inch diameter pulley mounted on the shaft of a ⅛ hp 1725 rpm motor and driving a 1.353-inch diameter pulley mounted on the spindle. With this drive, the centrifuge comes up to its 8100 rpm operating speed almost instantaneously.

BELT DRIVE



Industry's New Power Transmitting Medium
SWEEPS AWAY DESIGN RESTRICTIONS

In one application after another, "Timing" Belt Drives have enabled machine designers to achieve basic engineering improvements—or to design entirely new machines—that were previously either impractical or impossible! For never before has there been a *positive drive* that combined all these desirable characteristics:

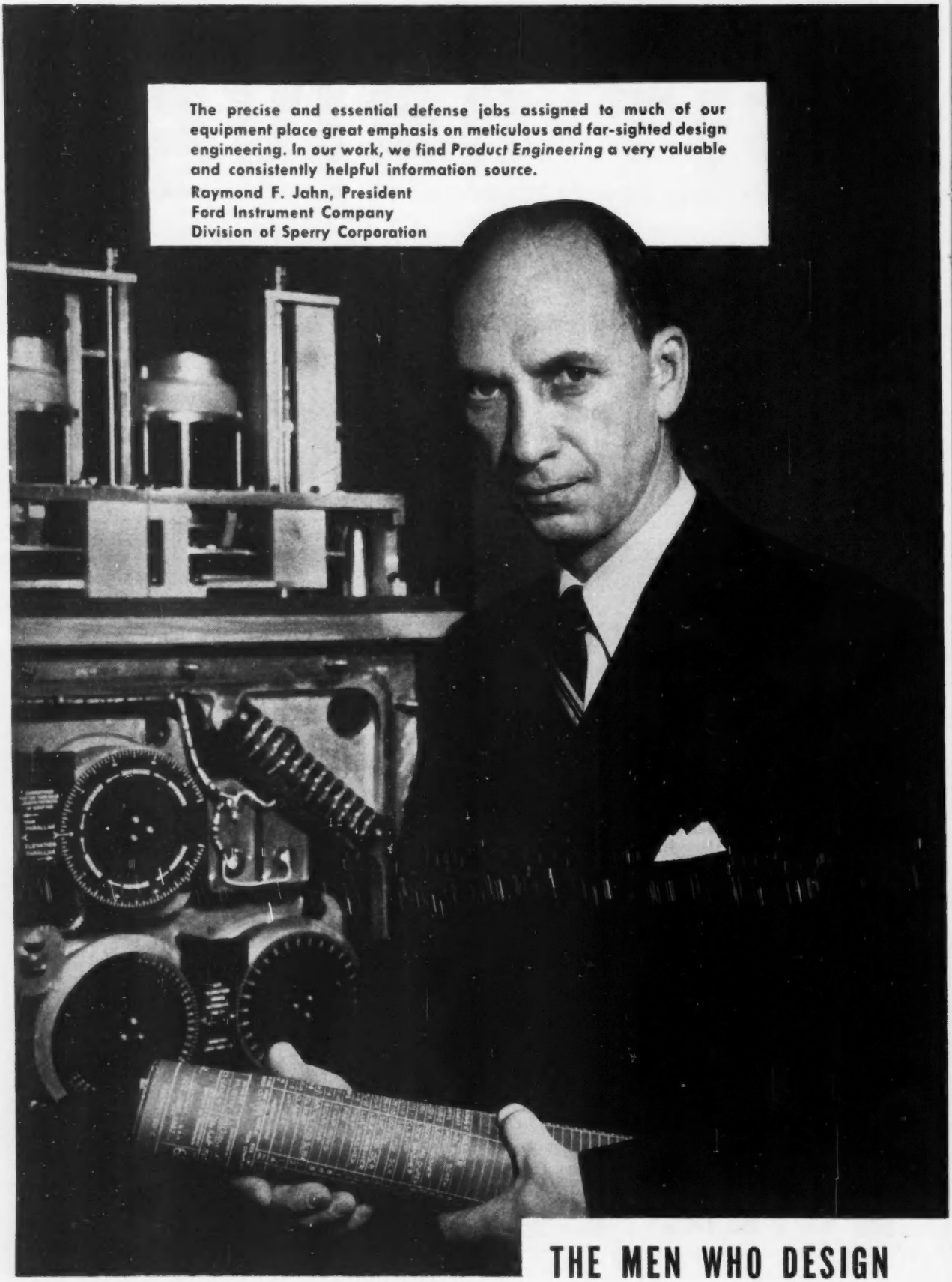
- **Requires no lubrication, no housings or lubricant guards.**
- **Maintains precise synchronization ("timing") between shafts.**
- **Provides speed ratios as high as 15 to 1 in a single step.**
- **Operates satisfactorily at speeds from inches per hour to 15,000 fpm.**
- **Permits use of very small diameter pulleys for ultra-compact drives.**
- **Has nearly 100% mechanical efficiency.**
- **Needs no initial tension. Lighter bearing loads permit lighter bearings.**
- **Does not stretch or lengthen with use; requires no take-up.**
- **Can be designed for zero backlash.**
- **Capacity ranges from 1/100 to 300 horsepower.**

These are but a few of the unique features of this amazing tooth-grip belt drive that is already in successful use on hundreds of thousands of machines. Consult your local NYB&P Distributor—or write direct—for the new "Timing" Belt brochure describing in more detail the "Timing" Belt and many interesting applications. Address: "Timing" Belt Division, New York Belting & Packing Co., Tacony, Philadelphia 35, Pa.

NYB&P

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products


The precise and essential defense jobs assigned to much of our equipment place great emphasis on meticulous and far-sighted design engineering. In our work, we find *Product Engineering* a very valuable and consistently helpful information source.
Raymond F. Jahn, President
Ford Instrument Company
Division of Sperry Corporation
THE MEN WHO DESIGN

He sparks design at Ford Instrument

HE READS PRODUCT ENGINEERING

The reasons why he does are basic to your sales future

Dedicated to the design of precise and intricate equipment of many essential types . . . among them gunfire computers, helicopter transmission units, and offset bombing systems . . . he reads *Product Engineering* for the same reasons design-engineering leaders everywhere in industry read it.

He does so because this magazine's pages bring him a wealth of purposeful information nowhere else obtainable . . . and all of it geared to answer his never-ending quest for new ideas in product design. All the latest facts on new developments in design are here for him to read and study . . . and to put to work in the challenging job of making fine products still better.

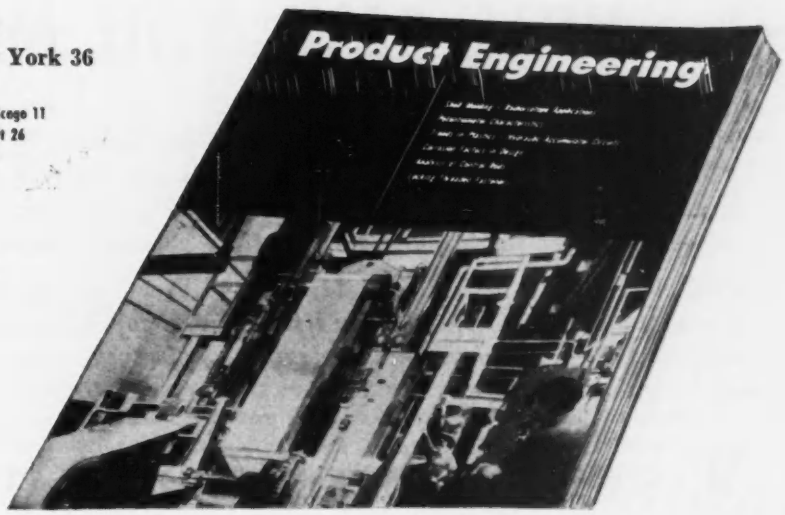
And for you who sell parts, materials, components, or finishes to industry, this fact is basic: over 20,000 leaders in industry's Design-Engineering Headquarters subscribe to *Product Engineering* because . . . more than any other publication . . . this magazine *helps them in their jobs.*

This quality of helpfulness, to the men who exert industry's essential voice in the purchase of your products, makes *Product Engineering* an outstandingly resultful advertising medium. A medium in which over 800 advertisers invest far more advertising dollars and pages than are invested in any other design publication.

When you want bigger sales in the $26-billion Original Equipment Market, you concentrate your advertising in *Product Engineering.* Ask our nearest representative for all the facts about this magazine's exclusive sales values.

A McGraw-Hill Publication
McGraw-Hill Building, New York 36

DISTRICT OFFICES: Atlanta 3 • Boston 16 • Chicago 11
Cincinnati 8 • Cleveland 15 • Dallas 1 • Detroit 26
Los Angeles 17 • New York 36 • Philadelphia 3
Pittsburgh 22 • San Francisco 4



AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

In these days of

HIGH DIE COSTS

MicroRold® Stainless Steel Sheets

WILL SAVE YOU MONEY!

The unusual uniformity of gauge in MicroRold allows for closer die setting, assuring the fabricator of uninterrupted production in stamping, forming and blanking operations.

This closer control of MicroRold sheet thickness ***increases the productive life of the die and reduces to an amazing degree the number of rejects.*** One fabricator reports less than ½ of 1% breakage in a 12½" draw on a 17" blank with a rectangular cross-section.

From edge to edge—and end to end—only MicroRold has such outstanding uniformity of gauge.

WASHINGTON STEEL CORPORATION

WASHINGTON, PENNSYLVANIA

Perspectives~ DESIGN AND DEVELOPMENT

ATOMIC ENERGY CONTROL

Contrary to current Washington rumors, when Congress finishes investigating government control of atomic energy, they will extend the Atomic Energy Commission's monopoly on the atom. But observers expect the new legistators will demand relaxation of some restrictions imposed by the Atomic Energy Act of 1946 (McMahon Act).

Complete relaxation will take several years, anywhere from five to ten. Even though the new Republican legislature is bent on reform, it is still a security-minded congress. One of the major questions investigating congressmen will try to answer: Can security be attained better through secrecy or achievement?

There's little doubt, in industry and government, that the quickest way to solve scientific and engineering problems is to turn competitive enterprise loose on them. In the past, companies have been reluctant to start atomic development projects on their own because the McMahon Act forbids the granting of patents for such processes or equipment. That's one restriction Congress will attempt to relax.

It's expected that AEC will back the plan to bring industry into the atomic energy picture. They need help on solving some complicated problems. But industry will benefit too. As a starter, AEC may release data they've painfully collected on zirconium, a formerly useless metal.

ZIRCONIUM

In the same chemical family as titanium, zirconium is expected to have many of the same properties. AEC uses it as extensively as they can because 1) it's tough, 2) it's corrosion resistant, 3) it has good strength at high temperatures, and 4) most important, it has a low neutron absorbtion cross section. That means that zirconium will not absorb neutrons very well, so it can be used inside nuclear piles without disrupting the fission reactions to a serious extent.

AEC has classified information on the metal because it is so scarce and they feared competition for the limited supply. It's rumored that zirconium is as tough to fabricate as titanium so AEC would like to develop other materials with similar properties. Because its use is new, the metal is very expensive and production is limited.

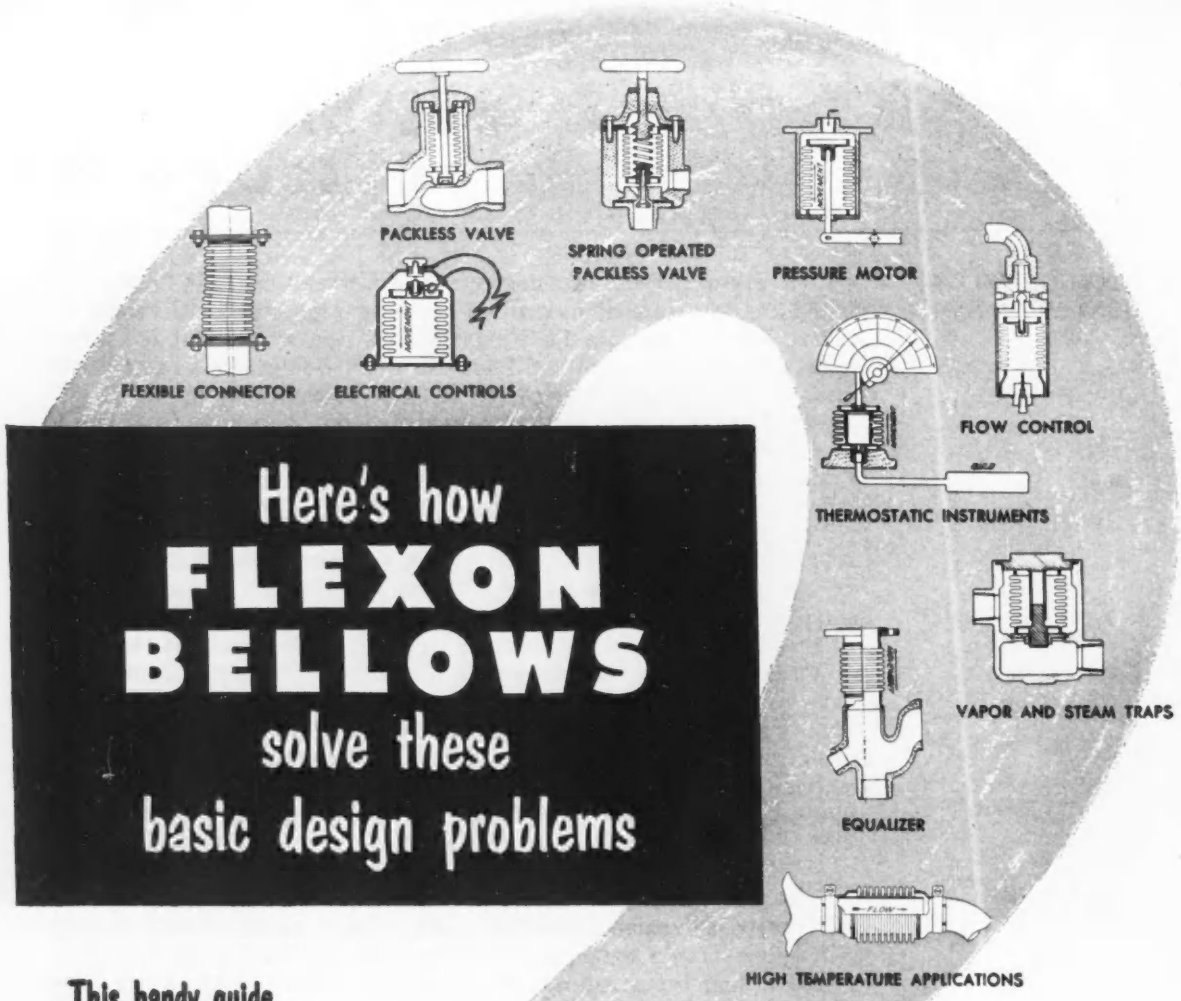
ATOMIC POWER PLANT

Most easing of restrictions will probably take place in the area that has the most promise for future private operation--generation of electric power from atomic reactors. Despite considerable publicity to the contrary, utility people feel that a successful unit is a minimum of ten years away, probably twelve.

AEC estimates that it will take four or five years to build a pilot power plant and at least as many more years to make it efficient enough to compete with even the most expensive electric power plants used today.

The Commission will ask Congress for funds to build this prototype electric power reactor. This doesn't mean that they plan to extend government operations into the atomic power business. Both industry and AEC experts agree that no more progress can be made without a full scale power plant. Because of reactor costs, legal restrictions, technical and economic uncertainties, industry is in no position to take on the job.

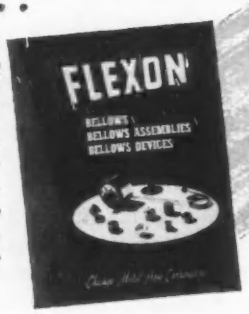
(continued on page 115)



Here's how FLEXON BELLOWS solve these basic design problems

This handy guide will help you . . .

The Flexon Bellows Design Guide offers useful application data and basic specifications on Flexon brass and stainless steel bellows. If you do not already have a copy, write for yours today, or see Flexon Bellows specifications in Sweet's File for Product Designers.



In any product that requires a motion controlled by temperature, or where a shaft or similar part must be sealed without packing, Flexon Bellows will answer the problem—and assure quality performance.

Flexon Bellows are manufactured by advanced methods to combine economy with exceptionally high standards of uniformity. They are available in brass, bronze or stainless steel in a complete range of sizes to meet virtually any need. For unusual applications, Flexonics bellows engineering specialists will be pleased to assist you. For quotations or recommendations, just send an outline of your requirements.

Flexonics *Corporation* **FLEXON BELLOWS DIVISION**
1351 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

ATOMIC PROBLEMS

Here are some typical problems on which AEC wants industry help:

1) What sort of heat transfer system, including a coolant, can be developed to withstand both high heat and radioactivity? New heat exchangers must be developed since the coolant flowing through the reactor will become radioactive and cannot be permitted to contaminate unshielded components.

2) What materials can be developed for building the reactor itself? They must have good strength at high temperatures, corrosion resistance, low neutron absorbtion cross sections, good strength-weight ratios, be relatively easy to fabricate, etc.

3) What cheaper means of shielding reactors and other "hot" components can be devised?

4) Can a new, more efficient method be worked out for removing radioactive wastes from a reactor and disposing of them? Disposal of waste materials is done now by chemical processing, but it's enormously expensive. So is processing of uranium or plutonium fuel that cannot be left in a reactor until it is entirely consumed.

5) How can electronic controls be improved and simplified to facilitate reactor operations.

While vexing, these problems must be solved before the atomic reactor, which will merely replace the boiler in current generating equipment, can compete economically with coal or oil.

INDUSTRY OPERATION

As with other major atomic projects, private firms will build and operate the power reactor under contracts from AEC. But Congress wants to remove some of the legal barriers to private construction and ownership of subsequent plants. Heading the list:

1) the ban on private ownership of fissionable materials;
2) the ban on owning facilities to produce fissionable materials;
3) the ban on issuance of patents for atomic developments.

OPPOSITION

But there is considerable opposition in Washington to lowering the bars even a little on atomic secrets. The resistance stems from two sources: defense and economics.

Some security-minded people feel that the gains from turning loose many of these secrets will not outweight those that will accrue to Russia's atomic developers.

Too, public power spokesmen point out that the U.S. has invested over 12 billion dollars to bring atomic energy to its present stage of development. They don't feel that industry should be given the opportunity to profit or set up power monopolies on taxpayers' investment. This leaves congress with the same dilemma they have on government-owned synthetic rubber plants (PRODUCT ENGINEERING; May 1952, p.113): How can they turn them loose?

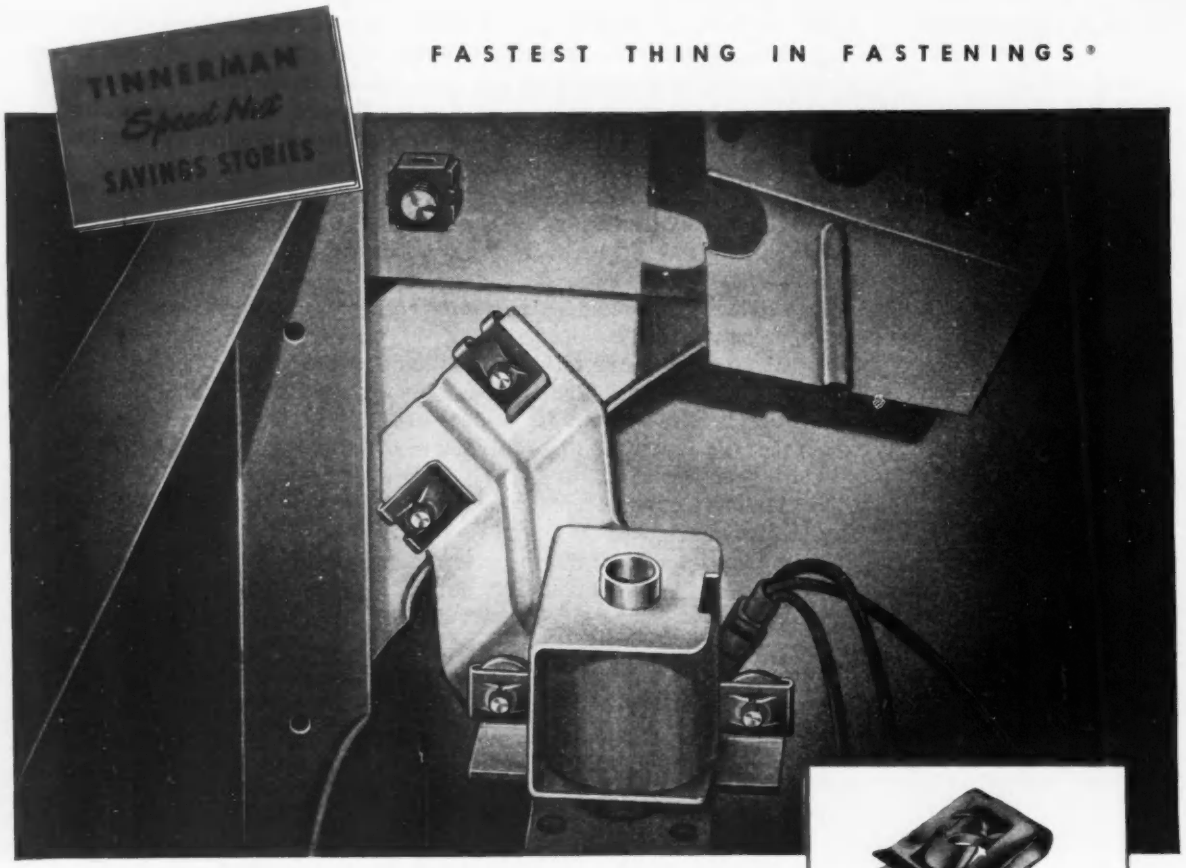
SECRECY IN RESEARCH

National Science Foundation should complete an intensive study of government sponsored research this year. Major question to answer: Are government agencies overdoing secrecy on research projects?

While the U.S. poured over $3 billion into various projects last year, not much information is getting out. Charges are that red tape and excessive security consciousness is damming up the flow of technical data. This is what happens in many cases: one agency studies problem, finds a solution, and then classifies the material. Secrecy is so strict that other agencies don't know about it. So another agency with the identical problem starts from scratch on the same research.

NSF will try to find out: 1) how many reports are coming from government research, 2) what use can be made of them, and 3) how to get them quickly to the people who need them, government agencies and industry contractors, who in the past have gotten only a trickle of data.

FASTEST THING IN FASTENINGS®



BENDIX Perfect Laundry Pair "Cleans Up" with SPEED NUT Savings!

For years, Bendix engineers have relied on SPEED NUTS to cut assembly costs and step up production schedules. That is why SPEED NUT brand fasteners were specified on the new "Perfect Pair" automatic washer and dryer units. Here is a direct quotation from a recent Bendix report . . . ". . . because we design from the ground up with Tinnerman, we effect basic economies. These include lower production costs and greater efficiency that result in lower retail prices and reduced service costs for consumers. Thus, in our production, we consider Tinnerman products more basic than nuts and bolts." Chances are your Tinnerman representative can turn your assembly problems into production savings. See him soon for details on the Fastening Analysis Service available for your products!

U-TYPE SPEED NUTS are self-retaining, snap in place over panel edges or center-panel locations; remain in bolt-receiving position for fast, easy assembly.

SPEED GRIP Nut Retainers snap in place by hand . . . no welding, clinching or staking. They reduce materials handling and are ideal for blind fastations.

A copy of "SPEED NUT Savings Stories", an interesting booklet of typical Tinnerman savings to industry, is yours on request. Write: TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario, *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France.* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine).

Why Can't We Do It Too

TEAMS SENT FROM VICTOR COUNTRIES searched Germany with great thoroughness to uncover scientific and engineering accomplishments. Much was found. Confiscated materials ranged all the way from rockets to hollow pins.

The United States of America boasts about its great technology, its wonderful mass production techniques, the bigness with which the nation plans. But the hydraulic presses found in Germany after the war are several times as big as the biggest which were then in the United States. German die casting machines were found operating at pressures much higher than the highest used in American machines. America no longer has a monopoly on that kind of bigness.

When it comes to fundamental scientific and design advancements, the World War II German submarines were in a class by themselves. That American ingenuity was able to develop instruments that finally all but wiped out the submarine menace, does not detract from the amazing design of the U-boats. In the field of ordnance many American guns could not match their German counterpart in performance. Even after several years, American engineers found it impossible to duplicate the design of at least one type of captured German rocket.

All of this is not to imply that America is deficient in its science and engineering. We have our greatness but too many of us have the attitude that we have all the greatness. We should be more humble. Much more would be gained if as much time and effort were spent in an attempt to analyze the whys and wherefores for the greatness of German technology as was spent in ferreting out inventions and products that might be carried away bodily. There are many important questions which could be answered only by careful study and analysis of German operation of schools and engineering and research departments.

How was Germany able to accomplish what she did in spite of the unfavorable conditions created by her defeat in World War I? It has been claimed that the Nazi regime hampered German scientific and technical progress. In view of the tremendous German developments during the thirties, that statement requires explanation. Why was German science and technology able to get so far ahead of that of other countries? Are the German technical universities the finest in the world? Is the German college professor held in higher esteem and is he better rewarded than his foreign counterpart? Does German industry give their engineers greater authority, greater freedom of action, higher prestige and relatively better pay than engineers in America? What must the United States do to reach a comparable scientific and technological level and what must be done to insure a high rate of continuing engineering and scientific progress in the United States?

The answers to these questions are far more important and valuable than are the confiscated products and patents that have been taken. Those are but items and details, merely examples of the fruits of a national operating philosophy that has developed superior scientific and engineering talents. If the fundamental principles that were put into practice in this operation can be discovered, analyzed and transplanted to America, then and not 'till then can we hope to equal or excel the hitherto unmatched scientific accomplishments of the Germans.

Teams have visited Germany to study their social and educational operations. Some information has been gathered but the amount is meager. Most of the reports have been simply filed away. Nor has American industry given sufficiently serious attention to the study and analysis of the operation of German research laboratories and engineering departments. Much more should be done.

George F. Rodenhoff

Finer Than a Watchmaker's Masterpiece!

This operation is typical of the laboratory-like techniques used on many precision bearings. The highly skilled operator is wearing special kid gloves to avoid contaminating the ball bearing.

New Departure ball bearings are quickly available at your equipment dealer or bearing distributor—supplied from the industry's largest nation-wide network of warehouse stocks.

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

Also Makers of the Famous New Departure Coaster Brake

The finest products of the watchmaker's art do not reach the high level of precision attained by New Departure ball bearings. Manufacturing standards which insist on certain tolerances being held to millionths of an inch give these bearings the ability to provide the virtually friction-free support demanded by modern motors and machines.

Designers and manufacturers can rely on New Departure ball bearings to increase the accuracy of their machines and products. It pays handsome dividends to consider New Departures when designs are still in the formative stage . . . for their use makes possible higher speeds, less maintenance and simplified designs.

Research, engineering and production at New Departure are focused upon one major objective . . . making the *best* ball bearings for every kind of application. Keep your eye on the BALL to be sure of your BEARINGS!

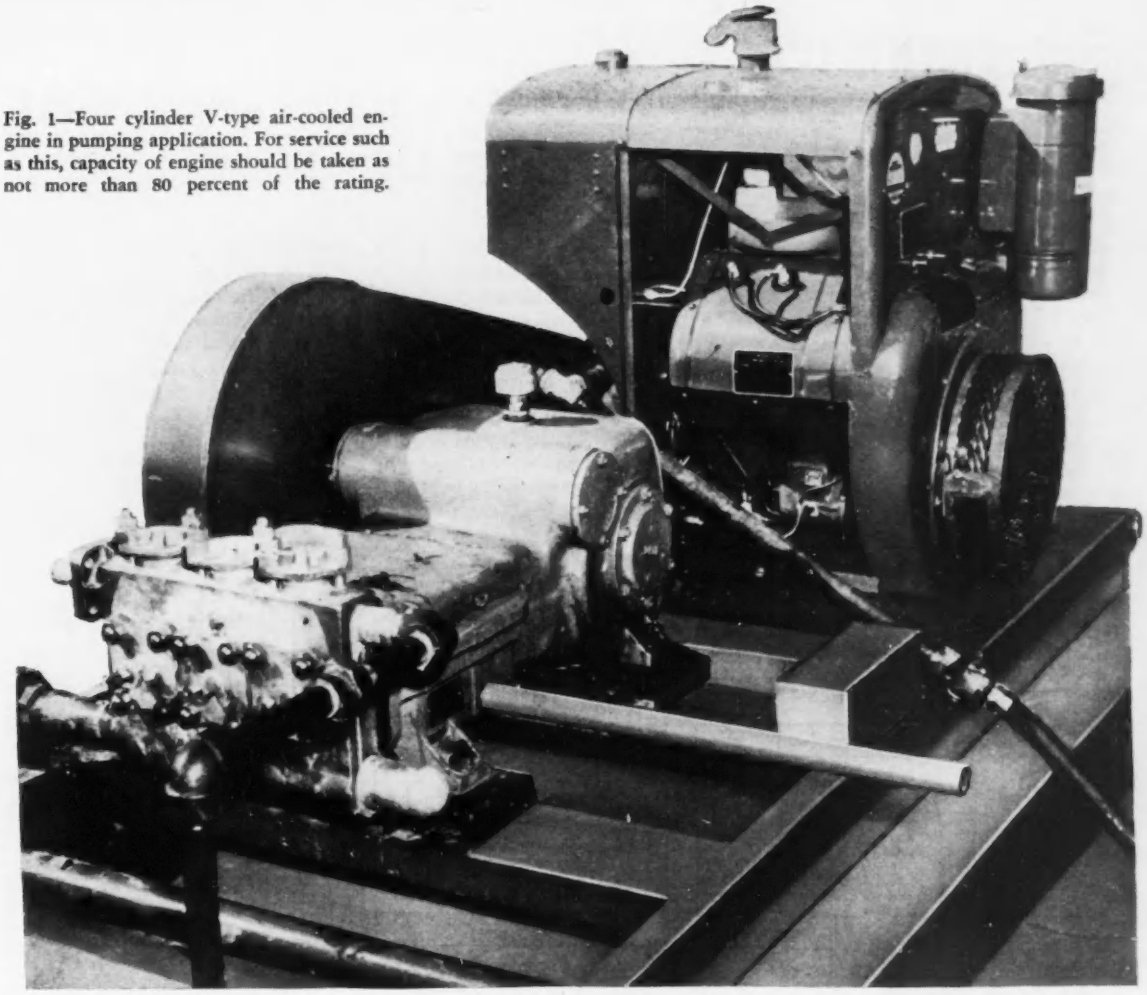


Fig. 1—Four cylinder V-type air-cooled engine in pumping application. For service such as this, capacity of engine should be taken as not more than 80 percent of the rating.

Which Engine Should Power Your Equipment?

A. F. MILBRATH
Vice President and Chief Engineer
Wisconsin Motor Corporation

THE PHENOMENAL GROWTH of this country's productive capacity within the last decade has been paced by driven machines and equipment. In the general industrial field, electric motor drives have been used extensively, but in construction, agriculture, marine, oil and myriad other industries where (1) electrical power is unavailable and/or (2) a portable drive is required, internal combustion engines have taken over exclusively. Yet, little engineering information has been published that will aid in selecting and applying the internal combustion engine that will drive such equipment most efficiently and most economically. The most important recommendations can be summarized as follows:

1. Engines should have sufficient capacity to insure a factor of safety of 20 to 25 percent.

2. Between high and low speed engines, the latter have longer life, but first cost is higher.

3. In take-off couplings, the flexible types are preferred over most others.

4. A clutch is desirable, especially in heavier equipment, to disconnect the load and to make starting easier.

5. In operations where the air is loaded with dust or chaff, cooling air intake screens should be used.

6. An oil-bath type air cleaner should always be used ahead of the carburetor.

7. Engine mountings should be designed and located to avoid vibration.

8. There should be a free flow of cooling air to the flywheel fan inlet and also to the hot air outlet from the

engine, and recirculation of the hot air by the flywheel must be carefully avoided.

9. If the operation is continuous and heavy, Stellite exhaust valves and valve seat inserts should be used to insure long life.

10. Valve rotators are also of considerable value in prolonging valve life, and with Stellite valves, constitute an excellent combination for heavy service.

11. An experimental test machine is strongly recommended before quantity production is started.

Of course, the problem varies somewhat with engine type. But while this particular article discusses only the 4-cycle air-cooled gasoline engines, many of the same principles will also apply to all types of engines.

Table I—Duty Ratings for Combustion Engine Application

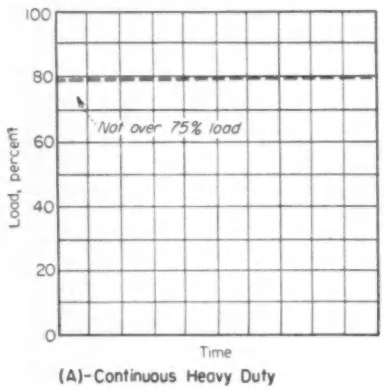
KEY: 1—Continuous Duty 3—Variable load duty, heavy
2—Intermittent heavy duty 4—Variable load duty, light

INDUSTRIAL SERVICE
- 1—Standby units
- 3—Air compressors
- 3—Floor sanders
- 4—Shop trucks and welders

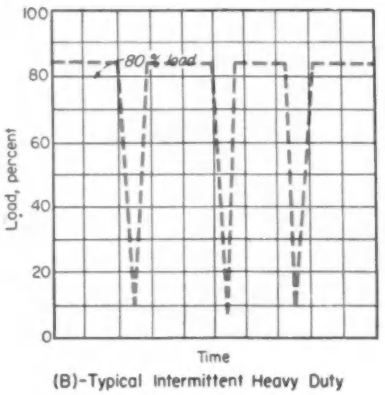
MUNICIPAL SERVICE
- 3—Street sweepers and flushers
- 3—Sanitary pumps
- 3—Pipe thawing rigs
- 4—Diesel starting units

RAILWAY MAINTENANCE
- 3—Tampers
- 3—Tie adzing machines
- 3—Railway maintenance cars
- 3—Rail grinders
- 3—Weed cutters
- 4—Rail leveling machines

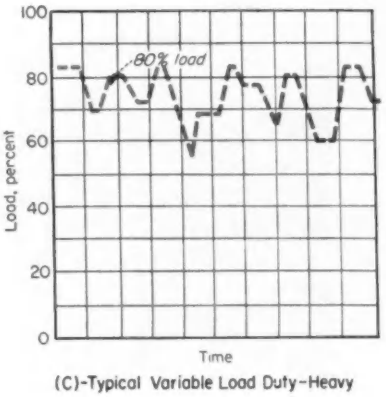
MINING
- 3—Horizontal & diamond drills
- 3—Rocker shovels



(A)-Continuous Heavy Duty



(B)-Typical Intermittent Heavy Duty



(C)-Typical Variable Load Duty-Heavy

SELECTING THE PROPER ENGINE SIZE

Exclusive of aircraft, air-cooled engines are usually applied in size ranges from about 1 to 30 hp. Larger engines are being built and, depending on the inherent cooling characteristics of the equipment, performing satisfactorily. However, the bulk of applications are on equipment requiring about 30 hp or less. The smaller engines up to about 8 or 9 hp are usually single cylinder types; from 8 to 15 hp, two cylinder engines are prevalent, while above 15 hp, four cylinder models are commonly used.

Within these ranges, air-cooled engines have several inherent advantages: they are light, with weight varying from around 14 to 20 lb/hp for a typical single-cylinder engine operating at 2,600 rpm to about 12 to 15 lb/hp for a typical 4-cylinder unit running at 1,800 rpm; auxiliary power requirements are low, since there is no radiator fan or water pump; there is no danger of the engine boiling or freezing, and no maintenance on fan bearings, belts, or water pumps; and first cost is low.

In selecting an engine of this type, the initial step is to determine the horsepower requirements of the driven load.

On equipment of entirely new design, it is often difficult to ascertain the amount of power necessary. In such instances, a rough estimate of the horsepower range is made and one or more sample engines bracketing the range obtained for use on experimental models of the equipment. In other applications, it is possible to calculate the torque required, from which the horsepower can be easily determined. Or, as is not uncommon, the new piece of equipment may be another size in a line of machines. In this case, the power determination can be made on a proportional basis.

Less frequent though none the less important is the occasion when it is desired to change the source of power from an electric motor to a gasoline engine. Electric motors are rated on an entirely different basis than are combustion engines. Most electric motors will develop 25 percent more power than their rating during a period of one or two hours, and, for short periods, may carry 50 percent overload. Gasoline engines, on the other hand, are rated at the maximum power that a new engine will develop on a dynamometer test conducted at an ambient temperature of 60 F and a sea level barometric pressure of 29.92 in. of mercury. For every 10 F rise in temperature, there will be a reduction in power of one percent, and for every inch drop in barometric pressure, there

AGRICULTURAL EQUIPMENT

1—Irrigation pumps
3—Combine harvesters
3—Hay balers, tractors,
3—Insecticide sprayers
3—Rotary tillers
3—Potato harvesters
3—Mowers
3—Spreaders, dusters

CONSTRUCTION MACHINERY

1—Centrifugal pumps
2—Concrete mixers
3—Concrete vibrators
3—Concrete surfacing machines
3—Diaphragm pumps
4—Hoists and power saws

HIGHWAY MAINTENANCE

1—Road rollers
1—Bituminous sprayers
2—Concrete cutters
3—Graders

OIL FIELD EQUIPMENT

1—Well drills and pumps
1—High pressure pumps
2—Pipe wrapping machines
3—Pipe straightening machines

MARINE

1—Lighthouse units
1—Water oxygenation units
3—Inboard marine engines
3—Under water weed cutters

SPECIALIZED SERVICE

1—Airport service units such as air compressors, hydraulic pumps and generators
1—Weed burners
2—Refrigerated trucks
2—Paint sprayers
2—Portable fire fighting equipment
3—Miniature railways
3—Water purification units for armed forces
3—Cable reelers
3—Lawn mowers and rollers
3—Post peelers
3—Portable showers for armed forces

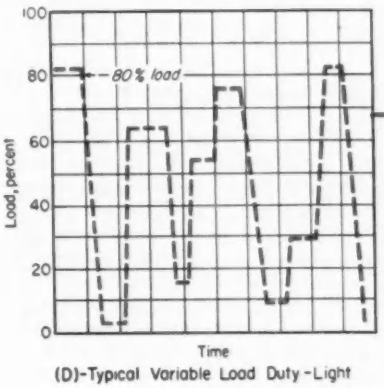


Fig. 2 (left)—Four classes of duty service normally encountered in internal combustion engine application. Beside allowances on this basis, deductions for altitude, temperature, and accessories must be made.

will be a 3.5 percent loss. Also, for every 1,000 ft of altitude, a power loss of 3.5 percent takes place. Thus, for average atmospheric conditions, the actual power of a gasoline engine is about five to seven percent less than the standard rating. If altitude is a factor, the loss is appreciable, reaching a figure of 35 percent at 10,000 feet.

Also, in keeping with good industrial practice, a gasoline engine is not generally operated continuously at maximum output, so that there is a factor of safety in the form of reserve power. Most engine manufacturers recommend that this factor be 20 to 25 percent below rated power. If the latter figure is assumed, the recommended operating horsepower for constant duty becomes 75 percent of the standard rating. Actually, duty cycle varies with different applications:

Continuous duty service, Fig. 2 (A), in which the engine is required to operate at constant speed and constant load. This is the type of service required by such equipment as water pumps operating under constant load, road rollers, and well drills. Since this is the most severe type of service, engines should not be loaded above 75 percent of the power curve.

Intermittent heavy duty service, Fig. 2 (B), where the engine operates under continuous load for a period of time, and then idles for a short period. This might include concrete mixers, sprayers, pipe wrapping machines, and similar equipment where there is full-load operation until a batch of material is finished or used up, after which the engine idles until another batch of material is supplied to the machine. This service is not as severe as continuous duty as there are periods when bearing loads and cylinder pressures are relieved and engine temperatures are reduced. For this service the engine load should not be above 80 percent of the power curve.

Variable load duty, Fig. 2 (C), covers quite a range of duty cycles, and this service may be roughly divided into heavy and light. The load may change from full-load to varying degrees of part-load or even no-load, in rather irregular cycles. Tractors, combine harvesters, and graders could be considered as belonging to heavy duty variable service, as the load would probably always be above 50 percent of full-load. In this service also the engine should not be loaded above 80 percent.

Light duty variable service, Fig. 2 (D), would include such equipment as hoists, power saws, and shop trucks where at times the load would reduce to zero. As the demand for power, at the intervals when required might be quite heavy, however, again the engine should not be loaded over 80 percent. No hard and fast rule can be set for all installations, but Table I lists various types of equipment and classifies the duty cycle that would generally apply to each.

To illustrate the procedure for converting from electric to gasoline engine power units, consider a machine that has been equipped with a 10.0 hp electric motor. As discussed above, this motor can deliver 10.0 plus 25 percent or 12.5 hp for short periods. On the basis that the gasoline engine is to operate at not over 75 percent of its rating, the replacement engine should have a rating of 12.5/0.75, or 16.7 horsepower.

In general terms, the gasoline engine should have a rating at least 67 percent greater than the electric motor it replaces. This applies to both air and liquid cooled engines for sea level operation under standard atmospheric conditions. If the application is at altitude, a further allowance must be made, resulting in some instances, in an engine having twice the power rating of the electric motor.

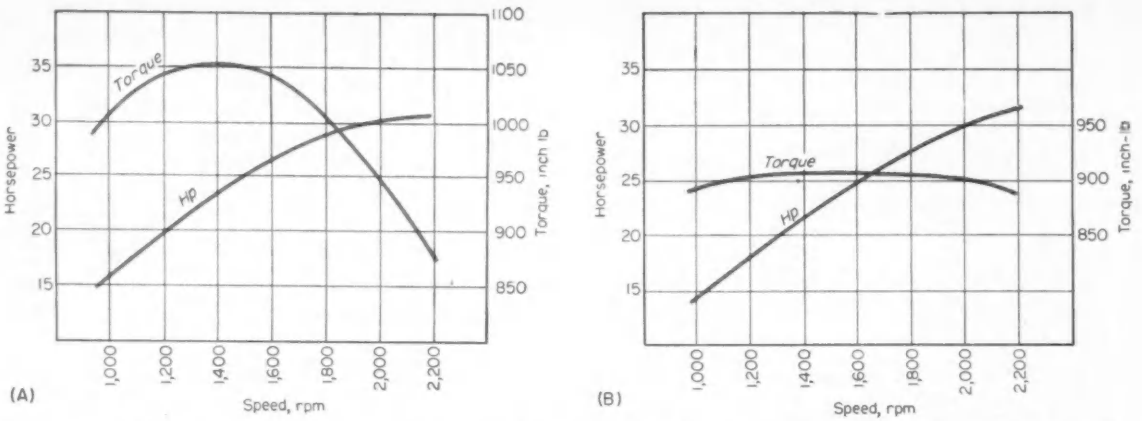


Fig. 3—Typical torque and horsepowerr curves for (A) industrial engine and (B) high speed engine. At 2,000 to 2,200 rpm, the engine represented at (A) has excellent lugging characteristics, while the unit at (B) is better suited for constant load applications.

ENGINE SPEED AND TORQUE

Once the power requirements of a design are known, the next consideration is engine speed, which is closely related to the horsepower and service life. The larger engines with their increased bearing surfaces and lower speeds, naturally require less frequent servicing and give longer, more trouble-free life than the smaller, high-speed engines of the same horsepower rating. The initial cost of the larger engine is greater but more frequent servicing can easily bring the cost of a smaller engine up to that of the larger one. Conversely, the smaller, higher-speed engine has advantages where lighter weight and smaller installation dimensions are important, as well as relatively low first cost.

Torque is, of course, closely associated with speed. For most installations, an engine with good lugging power is desirable, and in some cases, essential. This is especially true in tractors, harvesters, and hoists, where the load frequently increases considerably above normal. If the characteristics of the engine are such that the torque will increase with reducing engine speed, the tendency for the increasing load to reduce engine speed is resisted and the engine will "hang on". In short, it will have good lugging qualities, as indicated by Fig 3 (A). If the normal operating speed of the engine is 2,000 to 2,200 rpm, the maximum lugging properties will result.

If however, with this same curve, the normal operating speed of the engine is held at 1,400 rpm or below, stalling of the engine may occur easily when the load is increased. Such an increase will cause engine speed to reduce, resulting in a decrease in torque and causing a further reduction in speed until the engine finally stalls abruptly, unless the load can be quickly released. In Fig. 3 (B) are performance curves of a typical high speed engine with maximum power output at top speed. The torque curve in this case is flat and the engine is not as desirable for agricultural or industrial type installations.

The question often arises as to what engine speed will provide the best cooling. The velocity and volume of cooling air delivered by the combination fan-flywheel vary directly as engine speed. Since horsepower increases less rapidly than engine speed, especially in the upper ranges, there is more cooling air available per horsepower at higher speeds than at lower speeds. Also, the more intense scrubbing action of the higher velocity air against the cooling fins is a further advantage in favor of the higher engine speeds. For a definite amount of power to be taken from an engine, the cooling will be better at higher rather than the lower speeds.

Cooling requirements, of course, vary with different applications, and are dependent on such additional factors as ambient temperature, duty cycle, and engine location.

TYPE OF DRIVE

The selection of the type of drive between engine and driven equipment brings up a number of considerations. (See Fig. 4). There are various direct drive applications where the engine is provided with a crankshaft extension suitable for mounting a flange coupling, a flexible coupling, a sheave or pully for V-type or flat belts, or a sprocket for a chain drive.

A plain flange coupling is the least desirable of the above power take-offs, as great care is necessary in alignment to prevent binding of bearings. Even if a perfect job of alignment is made originally, springing of the base on

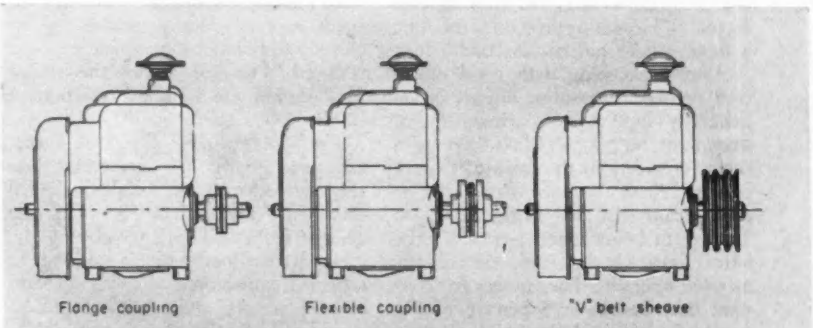


Fig. 4—Power take-offs for air-cooled engines. Fluid couplings also are used to

which the engine and equipment are mounted might occur. This applies also to equipment having an overhanging shaft that must be supported by an outboard bearing. Such a bearing must be carefully aligned on a rigid base on which the engine is also mounted. Flexible couplings or belt drives eliminate this alignment problem.

In many instances a clutch is required between the engine and equipment so that the power may be engaged or disengaged at will. A manually engaged clutch is the most common type in use on agricultural or industrial equipment. The housing for such a clutch is bolted to the end of the crankcase and centered by a pilot fit. On the end of the clutch shaft, the same methods of take-off may be used as mentioned above for mounting directly on the crankshaft.

Where automatic engagement and disengagement are desired, a centrifugal clutch may be used. These clutches can be furnished to engage at any speed between 500 and 1,200 rpm and the load pick-up is smooth and gradual. Typical applications for such clutches are refrigerating machines with thermostatic control for the starting and stopping of the engine.

Clutches also make starting of the engine easier. It is often impossible to start an internal combustion engine rigidly connected to the load. The engine may fire on the first turn of the crankshaft, but the first power impulses are weak and may not have sufficient force to carry the engine over to the next power stroke. This is, of course, much more the case with single cylinder engines than with multi-cylinders.

An exception and an excellent application of direct drive equipment is the centrifugal water pump, where the pump housing is centered and bolted to the crankcase of the engine, the impellor is mounted on the crankshaft extension, and finally the pump cover bolted in place. Another is the direct-mounted generator, where the field frame is mounted through an adaptor housing to the crankcase and the armature is mounted on the crankshaft extension. In these applications, the equipment runs at engine speed.

There are many applications where a speed reduction between the engine and machine is necessary. If the reduction is not too great, it may be accomplished by belt drive, but often a gear reduction is preferable. Gear reductions can be furnished in ratios up to 4 for the larger engines, and up to 6 for the smaller sizes. Many of these reductions can be furnished in either enginewise or counter-enginewise rotation, and either with or without clutches. Some can also be assembled to the engines with the take-off shaft offset in either one of several directions.

DESIGN AND CONSTRUCTIONAL FEATURES

There are many design or constructional features that can be specified for an air-cooled engine, but perhaps the most important of these can be summarized as follows:

Open or enclosed units. Occasionally the enclosed house-type unit is chosen for the sake of appearance of the complete piece of equipment, but more often the question of open or enclosed unit is based on utility reasons.

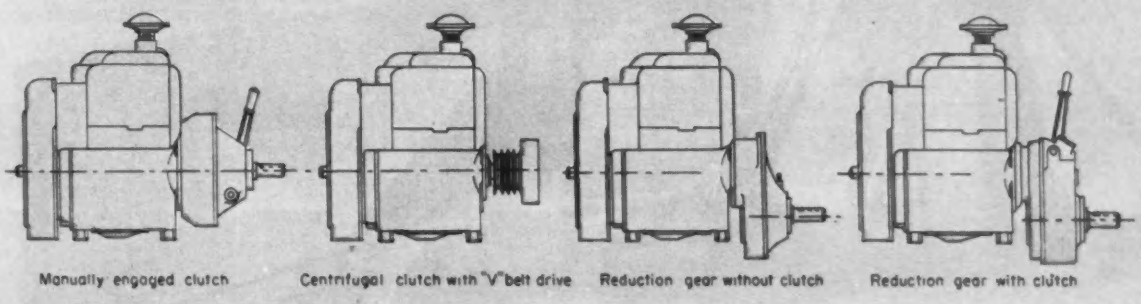
The open engine is used on a great many installations, especially on agricultural equipment. It has the advantage of accessibility and the free exit of the cooling air from the engine.

However, there are many installations where the house-type unit is preferable. For instance, on contractor's equipment which must often be left unattended on streets or building projects, it is advisable to lock up the units to prevent tampering. Also, where engines are mounted on such machines as belt conveyors or elevators, protection to the engine is provided against falling sand, gravel, and coal. When operating house-type units, the side doors or panels should always be removed to allow free exit of the cooling air.

Air Cleaners. All engines should be equipped with efficient air cleaners. The oil bath type cleaner is recommended, and greatly prolongs the life of the engine. In dusty operations, such as agricultural installations, a precleaner located fairly high so as to be above the heavy dust level will greatly reduce the frequency of the servicing operations on the main air cleaner.

Cooling Air Intake Stacks. Where there is considerable chaff, grass, straw or similar material in the air, means must be provided to prevent it from entering the cooling system and closing the air passages or cooling fins. This is done by installing an intake stack at the combination fan flywheel opening in the air shroud. Such a stack is made of sheet metal—usually of rectangular cross section—and extending upward from the engine with the upper end of the stack provided with screened openings on three sides. The side of the stack toward the cylinders should be of sheet steel to prevent re-circulation of the hot air from the cylinders through the system.

A circular rotating screen attached


Manually engaged clutch
Centrifugal clutch with "V" belt drive
Reduction gear without clutch
Reduction gear with clutch

cushion shock loads or to permit gradual acceleration of high inertia loads in some specialized applications.

to the engine crankshaft in front of the flywheel opening is sometimes used instead of an intake stack, especially on the smaller engines. Such a screen throws chaff or grass off by centrifugal force.

Drum type, or cylindrical screens attached to the flywheel air inlet on the shroud are also used and have advantages in some installations due to physical dimensions.

Hard Faced Valves. With compression ratios reasonably high so satisfactory power output and fuel economy may be obtained, practically all gasoline now on the market contains a certain amount of tetra-ethyl lead, to raise the octane rating of the fuel to prevent detonation.

When leaded fuels are used, there will always be lead deposits in the combustion chambers of the engines.

Where engine operation is variable both as to load and speed, the trouble from lead deposits is much reduced. However, there are many operations or types of service where constant speed and heavy loads prevail. In such cases, to reduce valve servicing operations, valves and valve seat inserts faced with Stellite or similar heat resisting materials are recommended. Such valves have a service life several times as long as ordinary valves, and while the original cost is higher, the first servicing operation of the ordinary valves will usually more than make up the difference in price.

Valve Rotators. To further reduce the frequency of valve servicing, several types of valve rotators have been developed in recent years. These devices cause a slow rotation of the valve during the time the valve is lifted off its seat by the camshaft, so that each time the valve seats, it is in a new position. This movement tends to make the valves wear uniformly and it also retards any build-up of lead and carbon deposits on valve seats.

There are two leading types of rotators, the positive and the free type. In the first, as the name implies, the mechanism positively rotates the valve while in the latter, the spring tension on the valve is released when the valve is lifted, so that the valve may turn freely. Both add greatly to valve life and when especially hard service is expected from engines, Stellite or similar valves with rotators are well worth the additional cost involved.

MOUNTING THE ENGINE

The installation of an engine on a piece of equipment is a most important problem. Every structure has a natural vibration frequency and if this frequency is in the range of speed at which the engine operates, the power impulses from the engine may, at times, synchronize to cause resonance. Very often it is not too difficult to change the stiffness of the engine support and frequency with it, so as to be out of the critical range. To calculate vibration frequencies of complicated structures is a cumbersome procedure and here again it is easier to build a test model of a new machine and then make corrections on engine mountings, if necessary, during the test period.

In some cases rubber vibration dampeners are advantageous. However, a haphazard selection of flexible mounts may increase vibration. Here again it is a matter of getting the right frequency and it is advisable to call upon the manufacturer of vibration dampeners for the proper selection of such fittings.

Of greatest importance in mounting the engine is the proper provision for air circulation. The cooling air inlet to the flywheel housing must be unobstructed. The outlet for the air from the engine must also be free and the installation must be such that there is no possibility of the heated air leaving the engine being picked up by the fan flywheel and recirculated through the cooling system. Such recirculation would allow the engine temperature to rise to dangerous limits. Enclosures around the engine from which the heated air cannot be freely exhausted must be avoided by proper design.

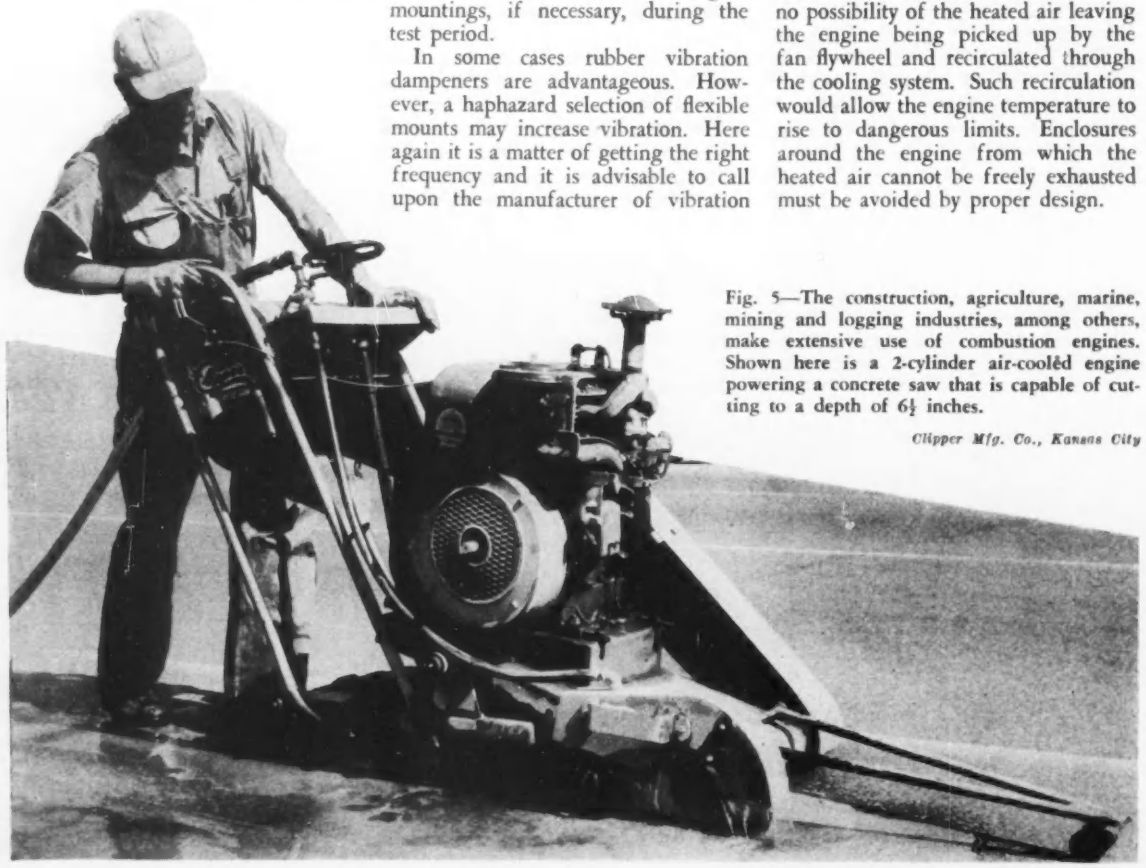


Fig. 5—The construction, agriculture, marine, mining and logging industries, among others, make extensive use of combustion engines. Shown here is a 2-cylinder air-cooled engine powering a concrete saw that is capable of cutting to a depth of 6½ inches.

Clipper Mfg. Co., Kansas City

Table I—Gall Test Data, Comparing Ductile and Gray Cast Iron

Type of Iron	Type of Graphite	Composition (percent) C	Si	Ni	Mn	P	S	Tensile Strength (psi)	Brinnell Hardness Number	Scoring Load (lb)	Galling Load (lb)
Gray	Fine Flake										
	Dendritic	3.1	1.7	2.0	0.8	0.09	0.09	30,000	224	150	190
Gray	Coarse										
Inoculated	Flake	3.0	1.8	2.7	0.7	0.09	0.09	36,000	218	300	400
Gray	Coarse										
High Phos.	Flake	3.1	1.7	2.1	0.7	0.46	0.13	47,000	241	375	560
Ductile	Spheroidal	3.0	1.7	1.9	0.9	0.02	0.01	90,000	279	400	500
Ductile	Spheroidal	3.0	2.2	2.0	0.2	0.02	0.01	80,000	217	300	400
Ductile	Spheroidal	3.5	2.3	2.0	0.2	0.02	0.01	.....	212	400	500

Table II—Wear of Various Materials Sliding Against Hardened SAE 52100 Steel

(Rockwell C-60); Without Lubrication Sliding Velocity 5000 FPM Duration of test = 180 Minutes

Material	Percent Wear-Relative to Bronze at 100%		Total Wear Volume (in.)	
	50 gm Load	269 gm Load	50 gm Load	269 gm Load
Brass	——	——	(0.00109)*	(0.0025)**
Bronze	100	100	0.00020	0.0021
Beryllium Copper	425	81	0.00085	0.0017
24 S-T Aluminum	230	100	0.00046	0.0021
Ductile Iron	35	19	0.00007	0.0004
Gray Iron	20	12	0.00004	0.00025

*—Wear volume for 30 min. only. Test halted because of excessive wear rate
**—Wear volume for 15 min. only. Test halted because of excessive wear rate

Wear Properties of Ductile Cast Iron

In spite of the structural difference between gray cast iron and ductile or nodular iron the wear resistance of the latter is found to be substantially the same, and occasionally better, as a look at some wear test data and actual case histories given herein will indicate.

THE INCREASE in toughness and rigidity of ductile iron compared to gray iron has been attributed to a structural change in which the graphite is changed from flake to spheroidal form by addition of magnesium to the melt. The dependence of wear resistance of metals upon microstructure raises the question of the effects of this structural change on the wear properties of ductile iron.

Laboratory tests and actual experiences with ductile iron in wear applications indicate that it has good resistance to mechanical wear in both the lubricated and unlubricated conditions —not materially inferior to the best wear resistant gray cast iron.

The good wearing qualities of gray cast iron have been attributed to the amount, size and shape of the flake graphite distributed throughout its structure. These factors can be varied by the melting practice and composition, by inoculation and heat treatment to give the properties desired. From the standpoint of wear resistance the coarse flake graphite is superior to the finer flake grades.

Ductile iron is also available in several grades covering a range of properties. The principal classifications of as-cast grades include spheroidal graphite in a pearlitic matrix and softer grades with spheroidal graphite in a pearlitic-ferritic matrix. Annealing of either of these two grades produces a fully ferritic structure. A high phosphorous grade is also available where high strength and stiffness with only moderate shock resistance is required. The pearlitic grades are best from the standpoint of resistance to wear alone.

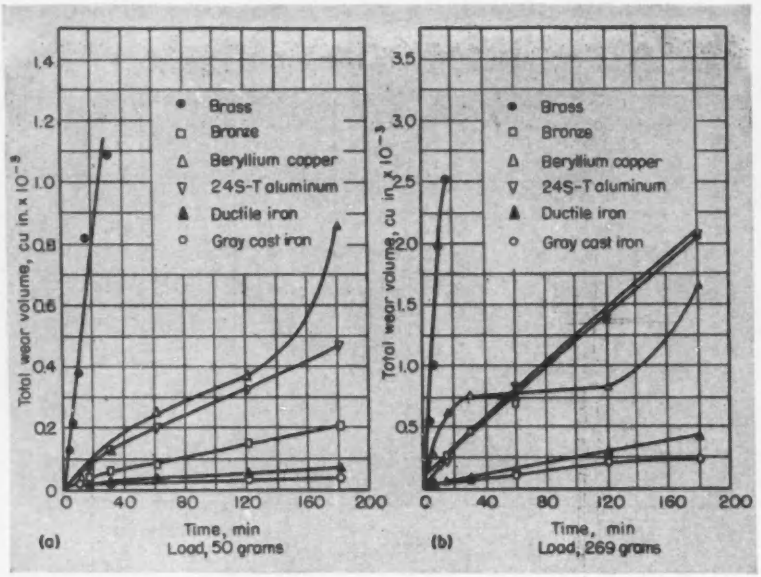


Fig. 1—Comparison of wear of materials sliding against hardened SAE 2100 steel.

Laboratory Results

The complexity of the factors causing wear and the many variables in the conditions found in different applications limit the value and dependability of laboratory test data. However some basic comparisons can be made between ductile iron and other metals that will at least serve as a guide although not as a rule in determining the suitability of this material for wear resistant applications.

The results of tests conducted at the Bayonne Laboratory of the International Nickel Company are shown in Table I. The purpose of these tests was to compare several grades of ductile iron with commercial grades of gray cast iron. The test procedure consisted of rubbing the curved side of a cylinder against the flat surface of an annular ring of the same material. No lubrication was used. The cylinder was oscillated 15 deg at the rate of 11 times per minute. The load between the specimens was increased by 10 lb with each oscillation. Loads that caused scoring and those causing galling or failure were recorded.

The data in Table I indicate that ductile irons have good gall resistance, comparing favorably with the coarse flake graphite irons. The dendritic graphite irons are inferior to both.

Table II and Fig. 1 present data based on an independent wear research program conducted by the National Advisory Committee for Aeronautics. Ductile iron is compared in wear resistant to gray iron and several nonferrous metals, sliding against hardened SAE 52100 steel (R_c60) without lubrication.

In this test ductile iron was found to have 3 to 5 times better wear resistance than bronze and again it compares favorably with gray iron.

The only real test for evaluating materials is to use them in actual practice and observe their performance. Experience with ductile iron has been sufficient to date to support the results found in laboratory tests such as those described above. The case histories given below present an overall picture of the variety of wear applications for which ductile iron has been found suitable. Although these are of a specialized character, they are suggestive of other uses that also involve stringent operating and loading conditions.

Piston Rings and Cylinders

The use of spheroidal graphite iron for piston rings and cylinders is receiving considerable attention in Europe to increase the life of internal combustion engines. European automotive engines have a small displacement but are run at high speeds—on the order of 5,000 to 6,000 revolutions per minute. Under these conditions gray iron pistons develop a lateral flutter that leads to excessive oil consumption and rapid fatigue failure. Because of the higher modulus of elasticity of ductile iron, piston rings can be developed with greater wall tension to prevent this lateral flutter. This development has met with encouraging success in Germany.

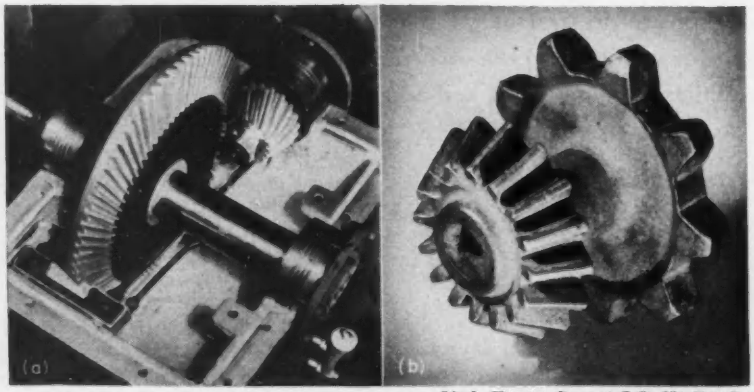
Although wear of ductile iron piston rings is 35 percent better than that of gray iron rings the cylinder wall exhibits a higher amount of wear than normal, bringing the net gain to between 15 and 20 percent. Making both the ring and the cylinder from ductile iron would probably result in better wear resistance.

Gears

There has been sufficient experience with ductile iron gears to substantiate the good wearing properties of this material as the following case histories will show:

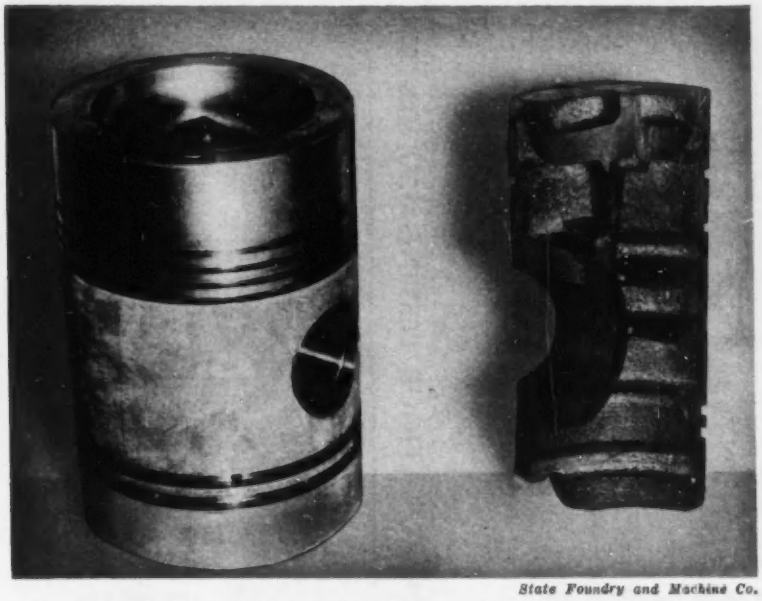
Ring Gears—Ductile iron ring gears used in flexible couplings for heavy gear reduction units, Fig. 3, showed few signs of wear after 50 million cycles—25 million at twice the normal service load and 25 million at four times the normal service load.

Oil Piston Motor Gear—Tests were conducted by a prominent propeller manufacturer on ductile iron piston gears working in an oil piston motor which is used to adjust the pitch of the propeller. This gear operated



Black Clawson Co. and Lakeside Foundry

Fig. 3—Gears made from ductile iron include ring gears (a), bevel gears, spur gears, and gear racks. The gear and sprocket shown in (b) are used in heavy farm machinery.



State Foundry and Machine Co.

Fig. 2—Ductile iron is being used for pistons and cylinders especially abroad.

between a fixed helix and a movable helical gear of type 4340 steel. The material formerly used for the piston was a high strength bronze with minimum properties of 110,000 psi tensile strength, 60,000 psi yield strength and 12 percent elongation. Excessive wear was experienced with this bronze gear in a short time. After 50,000 cycles of operation the bronze piston gear was badly scored whereas the ductile iron gear showed almost undetectable wear.

Bevel Gears—Bevel gears of ductile iron have been used in pumps handling crude petroleum products to replace gray iron gears. The latter has a service life of 300 hours and after this time showed severe pitting and wear at the pitch line. Ductile iron gears in the same application have run for over 1,000 hr with no evidence of deterioration or pitting.

Gear Racks—Washing machine gear tests have revealed good performance data in favor of ductile iron. Three materials were tested as gear racks for 1,500 hr at 50 percent overload—(a) type X135 manganese steel as forged, with a hardness of 200 Brinnell; (b) gray iron, annealed, with 120 BHN and (c) ductile iron annealed, with 175-200 BHN. The rack operated against a sintered high carbon steel gear, impregnated with copper, with a tensile strength of 85,000 psi. After the 1500 hr test the forged steel rack was severely pitted and worn and the teeth on the gray iron rack were worn down to about 1/3 their original height. The only evidence of wear on the ductile iron rack was a burnished appearance on the edge of the teeth. No pitting occurred. In addition to this advantage of better wear resistance the ductile iron rack in this case cost less than the steel and is now a standard production item.

Ductile iron gears in a variety of sizes and tooth forms are being used successfully in many industries, especially those requiring a heavy duty material, such as the cement industry, paper mill machinery and agricultural equipment.

Other Applications

Bearings—Heavy duty bearings, such as the bearings of a steel mill when made from annealed ductile iron provide a life of our to five times greater than bronze bearings at a substantial reduction in cost.

The higher strength of ductile iron compared to gray iron allows for thinner wall sections of bearings and bearing sleeves as well as providing good wear resistance.

Dies—A good example of the application of this material for dies is the heading die for ammunition cartridges shown in Fig. 4(b). This die was formerly made of tool steel with a life of approximately 45,000 shells. The ductile iron die as it is shown in the photograph has produced 875,000 cartridges. The cartridge shown is the 875,000th produced. This die is actually still serviceable.

The outstanding improvement in die life of ductile iron compared to tool steel in this application is attributed to the lubricating properties of the spheroidal graphite in the structure of the former.

In another die application 3,000,000 5 gallon gasoline tanks for the army have already been formed on ductile iron dies.

Other applications for which the wear resistance and bearing qualities of ductile iron are desirable include cams, sprockets, brake drums and crankshafts. This material can be flame or induction hardened to 550-600 Brinnell to obtain even greater resistance to wear. Such hardening can be done at selective areas where high surface hardness and a tough ductile core are required.

The combination of wear resistance comparable to gray iron and strength and impact properties approaching those of steel makes ductile iron an attractive, low cost material for many applications.

Acknowledgement: The material comprising this article was obtained from the International Nickel Co. of N. Y.

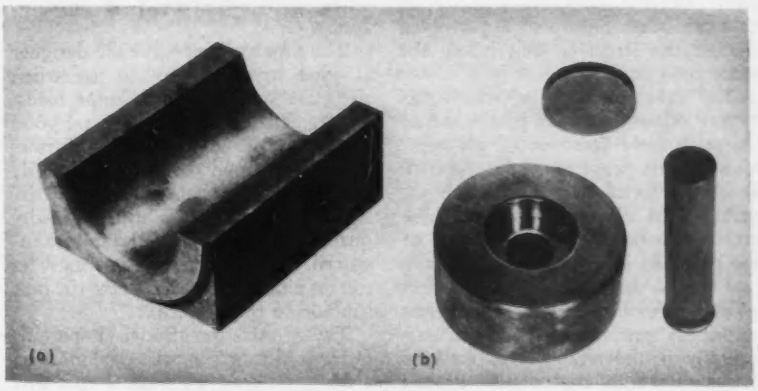


Fig. 4—The good wear resistance of ductile iron makes it acceptable for a number of severe applications including (a) heavy bearings and (b) metal forming dies.

FATIGUE TESTING

Its Machines and Methods

First of a series of articles covering the practical considerations of fatigue testing, including a general approach to the problem and descriptions of the types and operating principles of some typical single-purpose and universal testing machines.

COMMERCIAL FATIGUE TESTING MACHINES

Type	Class
Single-purpose	Rotating beam
	Rotating beam
Universal	Constant amplitude; crank
	Constant amplitude; crank
	Constant amplitude; hydraulic
	Constant force; free eccentric
	Constant force; free eccentric
	Constant force; free eccentric
	Resonant
	Resonant

T. R. BREUNICH
Project Engineer
Sonntag Scientific Corporation

THE ACCURATE DETERMINATION of fatigue strengths is important when equipment is subject to large or rapidly fluctuating dynamic loads. This is particularly true in present day aircraft and mobile vehicles where higher speeds and higher allowable loads per unit weight are being used. A material's static physical properties, as determined on conventional static testing machines, are no longer adequate for this type of design. Dynamic or pulse loading introduces a condition that can cause failure of a part even though the stress is well below the static yield point.

The value of stress at which this failure occurs is no set percentage of the static yield point, or of any other known static property of the material. It is determined by the material, the part design, the machining method, and the surface or heat treatment of the part. As an illustration of this, a part with a sharp fillet or a groove in a critical point will fail at low stress values. A part rough machined, particularly if the scratches or machine marks are at right angles to the applied force, will fail rapidly. A part machine polished may fail more rapidly than one with a good tool finish because of the tension set up in the skin by the heat of the polishing. Heat treating may increase the static yield point and decrease the fatigue strength because of minute quenching cracks or de-carburization of the surface. Shot peening and carburizing of the skin will usually increase the fatigue strength, while chrome plating will decrease it. Nickel plating can either increase or decrease the strength depending on the bath used. Certain types of cold working, such as rolling, will increase the fatigue strength. All of these variables must be considered when parts are subject to dynamic forces.

The problem that faces the designer is what strength value to use when parts are subjected to dynamic loads. Where existing data and general good design practice give adequate information, this method should be followed; however, on all but the simplest designs existing data is usually inadequate to evaluate all of the factors involved. This means that tests must be run on pilot parts to determine the best solution to the problem.

These tests are also an important factor in determining the economics of a design. Often, although a part will operate satisfactorily, its cost may be three or four times as large as necessary. Tests help to determine the best solution which will give the cheapest part adequate for a job.

Because the field of dynamic testing deals with vibrating bodies, careful consideration must be given to the selection of the testing machine and specimen so that reproducible and useful results are obtained. In static testing the force recorded on the machine is the force exerted on the specimen, while in dynamic testing there is the additional factor of inertia forces in the machine, the grips, and often in the specimen. Resonance can also occur in the machine or the specimen if the spring constants, masses, screw threads, pivot points or other parts combine in such a way that they resonate at the operating frequency.

One of the first steps in selecting a testing machine and setting up a series of fatigue tests is to analyze the fatigue load under question and to determine what is involved in simulating this load on the testing machine. This is important since the type of test and consequently the type of test machine is determined by these requirements if an accurate duplication of these fatigue loads is to be obtained.

A fatigue load is one that changes in magnitude at some cyclic rate. It may go from zero to maximum, from minimum to maximum without passing

Manufacturer	Capacity	Stroke Inches	Speed rpm	Loading Method	Available Extras
Krouse	0–1,000,000 in. lb		0–10,000	Cantilever and couple bending	Corrosion and high temperature
Sonntag	0–1,200,000 in. lb		0–3,600	Cantilever and couple bending	
Krouse	0–200,000 lb	±1/2	500–1,500	Tension-compression	Load maintainer and preload maintainer
Krouse	0–3,300 lb at crank	±3	650–2,000	Bending	High temperature and torsion testing
GM	±100,000 lb	±3/16	1,000–2,000	Tension-compression	Torsion testing
Sonntag	±50,000 lb	±1/2	1,200–1,800 Synchronous	Universal	Tension and compression, torsion, bending 5:1 amplifier
Sonntag	±2,500 lb bending ±5,000 T & C		3,000 Synchronous	Combined stress	High temperature, creep recording
Sonntag	±5,000 lb	±1/16	3,600 Synchronous	Tension-compression	High temperature, creep recording
Sonntag	±10,000 lb	±1/4	1,800–2,600	Tension-compression	
Schenck	±65,000 lb	±1/4	2,000–2,600	Tension-compression	

through zero, or from a minus value through zero to a plus value. The rate can vary over wide ranges. Technically, any load that varies is a fatigue load, but the low cyclic ones are usually considered static loads because the structure is obsolete before any appreciable number of cycles is accumulated.

Thus, under dynamic loads the part vibrates and deflects at some cyclic rate, and all fatigue testing machines produce a sinusoidal force in an attempt to duplicate this.

When a test specimen is being repeatedly deflected in a fatigue machine there are two forces present. One is the controlled sinusoidal forcing function which produces the simulated stress, while the other is an inertia force which is equal to the product of the mass of the vibrating parts, the square of the frequency, and the amplitude. Since this latter force is a variable, depending on the frequency and amplitude of vibration, it can introduce errors in tests where the total force must be accurately controlled. This is an important consideration, for the inertia force during high amplitude testing can be many times the controlled force, causing a large force error and inaccurate test results. Thus in carefully controlled tests these vibratory inertia forces must be either measured and included with the controlled force or be completely eliminated by means of compensating arrangements. Both of these approaches are used on standard testing machines.

When the preliminary load analysis has been completed, the type of test and type of testing machine must be selected. Test specimens range from standard material specimens up to complex structures, such as crankshafts, weldments, or gear trains. Some machines will test all types of specimen, others only one type, but none will test both large and small ones properly. Thus, fatigue testing machines, like all precision force devices, must be selected for the correct power range.

When a material is being tested or compared, or different methods of treatment are being checked, a standard specimen is usually used. This may be a bar or a machined specimen stressed in tension-compression, bending, torsion, or a combination of stresses. Standard machines are equipped to handle all of these types of tests. When more complex parts or actual structures are to be tested, special fixtures and possibly special machines are usually required. It is under these conditions that careful load analysis is necessary for good test results.

The final step in setting up a fatigue test is to select the testing machine and fixtures. The machine should have sufficient force capacity, the operating characteristics desired, and should be adapted or adaptable to the type of test selected. As much foresight as possible should be used to get a machine that will fit into future testing requirements, and an oversize machine should not be purchased just to have the extra capacity. As with all measuring and controlling devices, the greatest accuracy is obtained when operating above 20 percent of full capacity, and poor results are usual at 1 and 2 percent of capacity.

There are a wide variety of commercially available fatigue testing machines. Because of the difficulty of design and the high cost of a single unit, it is rarely warranted to build a special machine for a test. The designer should examine both the available machines and the test problem, and attempt to correlate the two. Even with the most intricate test requirements, it is usually possible to reach a compromise which will enable the use of a standard machine. In the event that a special unit is necessary, it is best to have it designed and built by a commercial supplier of this type equipment since he has the experience which is required.

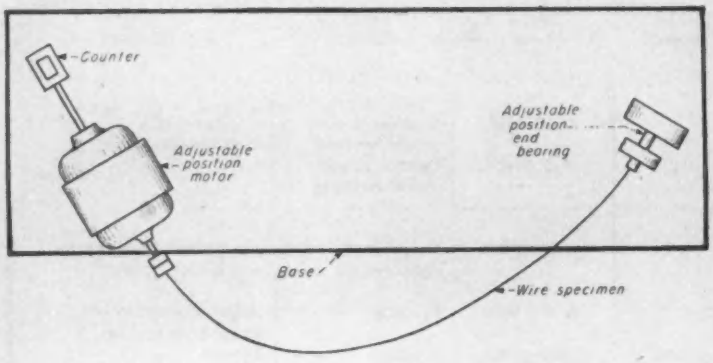


Fig. 1—Single-purpose wire specimen type rotating beam machine. The fatigue load is applied by rotating the wire and causing continuous stress reversals. The radius of curvature of the beam determines the magnitude of the maximum stress. This machine is only capable of handling wire specimens of a relatively small diameter. The cycles to failure are recorded on the motor driven counter.

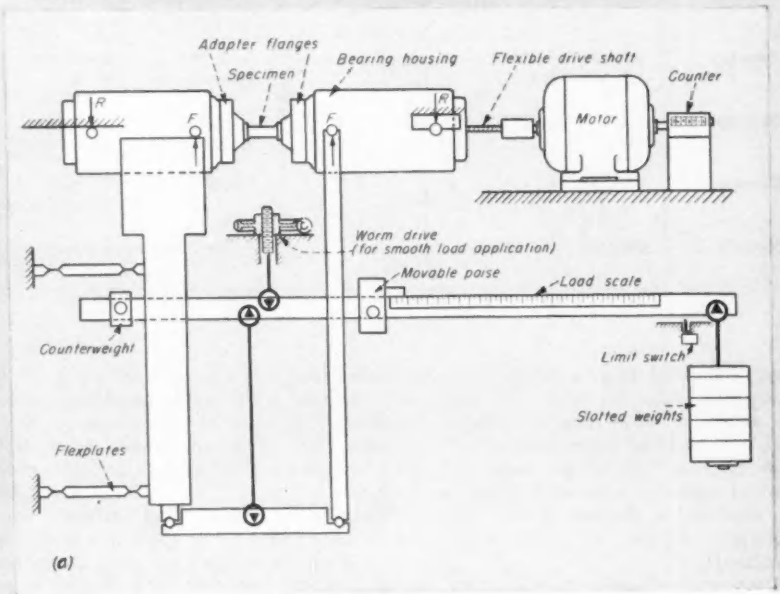


Fig. 2—(Right) (a) Schematic diagram of rotating beam machine which is capable of handling heavy cylindrical sections. Load is applied through worm and gear drive and balanced by varying weights or adjusting movable poise. Bending moment depends on the load at points F and on the length of the fixed lever arms. (b) Commercial version of machine. Notice that left hand bearing housing is permitted to move axially so that specimen is not subjected to tensile load in addition to bending load. Adapter flanges are available so that unit can handle various diameter specimens.

Commercial Testing Machines

Since the type and complexity of a fatigue test is limited by the capabilities of the testing machine, an engineer must be familiar with the types of machines available and the types of tests which these machines will perform.

Fatigue testing machines can be classified into four major types, with each type having its own specific subdivisions. The first type is the single-purpose machine which will handle only one type of specimen. The second is the universal machine, designed to handle various specimens from standard material shapes to structures. This type also has the space and fixtures required to handle bending, torsion, and special fatigue tests. The third classification covers semi-special machines usually adaptable to several types of specimens, but limited to certain types of tests. The fourth type consists of vibration generators or oscillators, used to excite specimens and structures to resonance. These are not true fatigue testers since the force applied to the specimen is low and not continuously controlled. The specimen fails when it reaches resonance, and the internal stress usually goes well over the yield point. However, since they are vibration testers, and suitable for many government tests, they will be included.

Single-Purpose Machines

The single-purpose unit, commonly known as the rotating beam machine, is one of the oldest types. It takes three basic forms and will only handle cylindrical specimens.

The machine operates on the principle that the top fibers of a bent beam are in tension and the bottom fibers in compression. A cylindrical specimen or beam is bent by applying a couple moment at each end. By rotating this bent beam through 180 deg, keeping the end angles constant, the fiber stresses are reversed so that the fibers that were in tension are now in compression. If this rotation is rapid and continuous, the beam is subjected to a fatigue load.

The simplest commercial machine, Fig. 1, uses wire specimens. The wire is clamped between an end bearing and a drive motor which are mounted

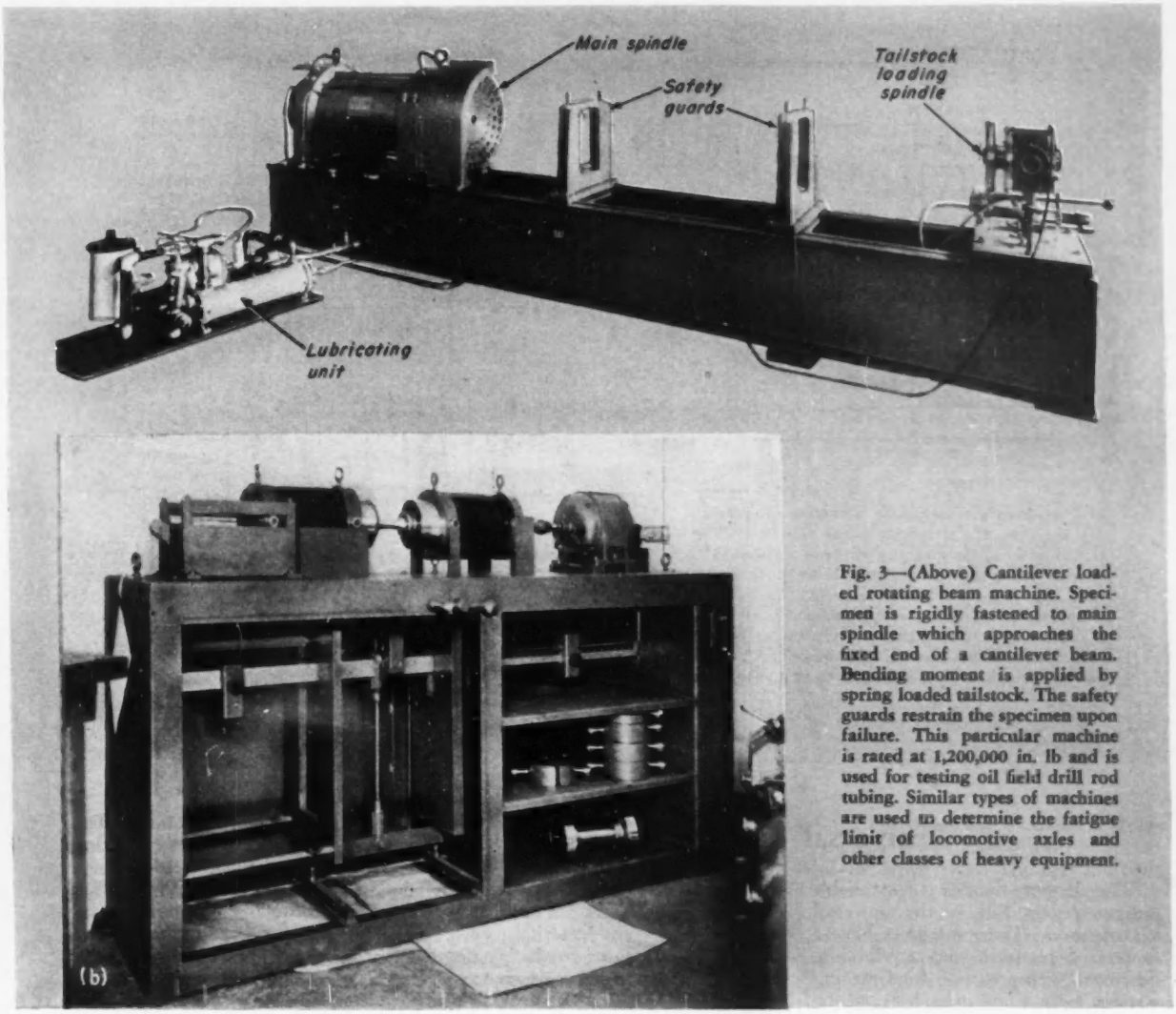


Fig. 3—(Above) Cantilever loaded rotating beam machine. Specimen is rigidly fastened to main spindle which approaches the fixed end of a cantilever beam. Bending moment is applied by spring loaded tailstock. The safety guards restrain the specimen upon failure. This particular machine is rated at 1,200,000 in. lb and is used for testing oil field drill rod tubing. Similar types of machines are used to determine the fatigue limit of locomotive axles and other classes of heavy equipment.

on swivel plates. The curvature depends on the length of the wire, with the radius determining the magnitude of the stress cycle. On failure the machine shuts off automatically and the cycles to failure are recorded on the motor driven counter.

A more complex version of this type machine, which is capable of handling heavier cylindrical sections, is shown in Fig. 2. Both ends of the specimen are pressed into grips, to give fixed end conditions, and these grips are secured to ball bearing supported shafts. The bearing housings are pivoted at points R, with the inside ends equally loaded at points F through a beam weighing system. The load is regulated by adding standard weights to the weigh beam and adjusting the sliding poise. This applies an equal and opposite couple to the two ends of the specimen and arches it upward. The resultant stress is a function of the fixed lever arms (distance from points F to R) and the weight indicated on the beam. The shaft which supports the right hand end of the specimen is driven by a motor through a flexible shaft; rotating the specimen. The left hand support shaft is free to move axially in its bearings so that no tension load is applied to the specimen. When failure occurs the weigh beam drops and opens the limit switch, which in turn stops the motor. The counter records the cycles to failure.

The third type of single-purpose machine is similar to the above but loads the beam as a cantilever. This gives a variable moment along the specimen in contrast to the constant moment as in the machine of Fig. 2. One end of the specimen is held in a long heavy spindle, Fig. 3, which rotates in a fixed bearing housing. This approaches a fixed end mounting. The other end of the specimen is mounted in a pivoted tailstock bearing and a force is applied by means of an adjustable spring loading system. The resultant stress follows cantilever loading formulas.

This machine is used for testing oil field drill rod tubing. Other machines of this type are used for testing special heavy sections.

The type of specimen which can be tested on single-purpose machines is limited since it must have symmetry as it rotates. These machines are usually used for materials testing where the object is to determine the fatigue characteristics of different materials. They have been adapted for elevated temperature and corrosive atmosphere testing in addition to the standard ambient tests.

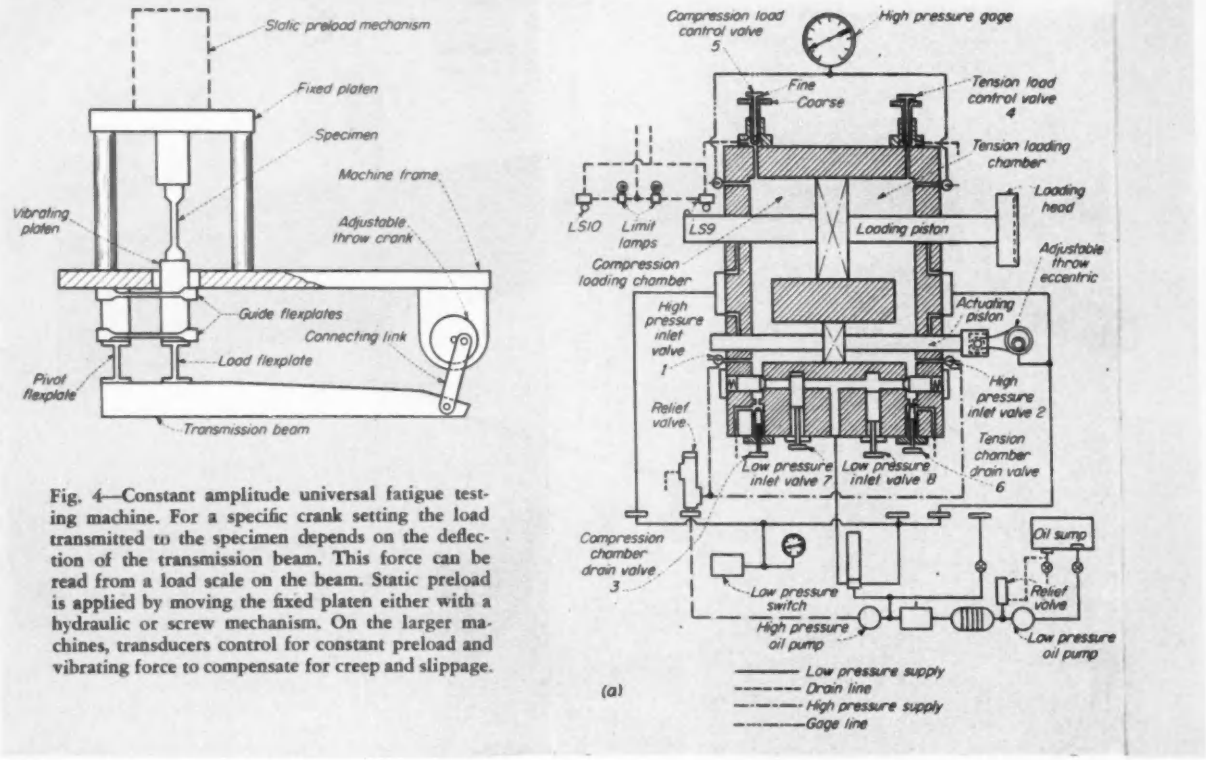


Fig. 4—Constant amplitude universal fatigue testing machine. For a specific crank setting the load transmitted to the specimen depends on the deflection of the transmission beam. This force can be read from a load scale on the beam. Static preload is applied by moving the fixed platen either with a hydraulic or screw mechanism. On the larger machines, transducers control for constant preload and vibrating force to compensate for creep and slippage.

Universal Machines

The largest number of available fatigue testers fall in the universal classification. These machines have a stationary platform and a vibrating platform, with provision for fastening various fixtures and grips between the two. The vibrating platen moves in a single plane, usually at right angles to the fixed platen, and exerts a controlled motion or force on the specimen. By the addition of various fixtures, the straight line motion can be transformed into bending or rotary motion for torsional or flexural testing.

There are three basic methods used on universal machines to generate and control the force. In one constant amplitude system, the motion is generated by a variable throw crank. For a specific test, the stroke is constant and the stress in the specimen is determined by the deflection of the transmission beam.

The crank, Fig. 4, moves the free end of the pivoted transmission beam through an adjustable stroke. The vibrating or specimen platen is connected to the beam at a point close to the pivot to give force multiplication. The vibrating platen is guided so that it can only move vertically, while the stationary platen is supported on columns. A static preload can be applied by moving the fixed head up or down and is measured by the bending of the transmission beam which has a calibrated force scale. The position of the fixed platen is controlled by a screw or hydraulic mechanism. The more complex machines have adjustable control contacts on the force measuring device. These act to maintain a constant preload force during the test.

The maximum dynamic force is set by either calculating the deflection of the specimen and beam and setting the crank throw accordingly, or by adjusting the crank until the force gage on the beam shows the desired value. The larger machines have force transducers that sense the load and automatically adjust the crank throw to correct for modulus changes and slippage during the test. Each machine has a chart of dynamic correction factors which are applied to compensate for the inertia of the vibrating parts.

The system used to guide the platen and the beam lever is of interest, since it is practically the only type of bearing guide that can be continuously subjected to oscillatory motion. The guides are flexplate sections consisting of I-shaped bars with the reduced section in the plane of bending. This permits them to bend without appreciable resistance in one plane, but maintains high rigidity at right angles to this plane and along the axis of the flexplate. The result is free motion along one axis and rigid alignment in the plane of the other two axes. The flexplates are designed to operate below the endurance limit of the material used. The distance between flanges is sufficient to keep side motion of the guided part, caused by the end of the flexplate moving in a circular arc, within acceptable limits. They do not wear out, are quiet, need no lubrication, and add negligible damping to the system. No other method of pivoting can compare either in performance or length of life.

Another type of constant amplitude universal testing machine, Fig. 5, uses a hydraulic control and power system to move a piston through a fixed amplitude stroke. The force is applied to the specimen by the large loading piston which in turn is controlled by the small actuating piston. The small piston is connected to an adjustable throw crank. By selecting the correct stroke on this crank the

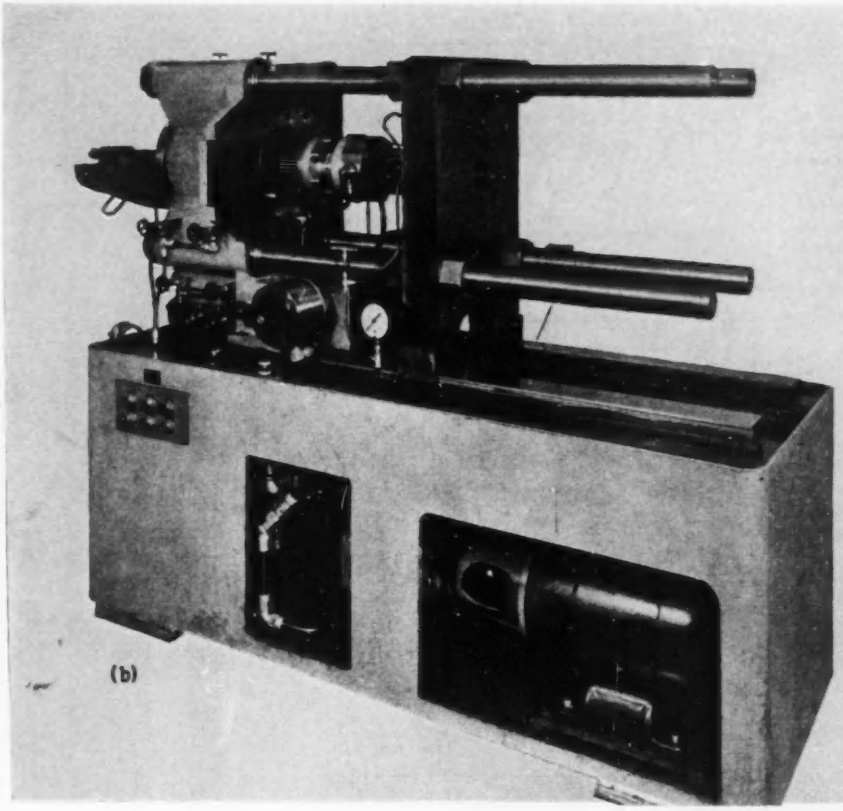


Fig. 5—(a) Schematic of hydraulically controlled and powered universal fatigue tester. Static stroke is set by manually positioning the loading piston with high pressure oil and adjusting limit switches. Corresponding dynamic stroke is obtained by selecting the proper eccentric throw. Final adjustments are made by bleeding oil until the limit lamps just flicker at each end of stroke. The hydraulic supply system is arranged so that the inlet to the high pressure pump is taken from the outlet of the low pressure pump. (b) Commercial version of hydraulically actuated tester. This unit requires no independent preloading attachment, since complete ranges of stress variation can be obtained by proper setting of loading piston stroke. Various fixtures are available for mounting different types of specimens. Adjustment for specimen length is made by moving fixed platen along columns.

large piston is forced to oscillate through a desired smaller stroke since the piston circuit is a closed hydraulic system during machine operation. The crank gives a sinusoidal motion to the small piston which in turn imparts the same type motion to the large piston.

The required stroke for any given stress variation is determined statically by moving the large piston with high pressure oil and sensing the load by means of a pressure gage. The left hand end of the stroke is set by admitting high pressure oil through tension chamber valve 2 and bleeding off through tension bleed valve 4 until the desired force is attained. Limit switch 10 is then set. Compression drain valve 3 must be open during this operation. The piston is then moved in the other direction by admitting high pressure oil through compression chamber valve 1 and a similar procedure followed; setting limit switch 9. The small piston stroke corresponding to this large piston stroke is set on the crank and the machine is started. By means of oil bleeds, the final stroke is adjusted until the limit lamps connected to the limit switches, just flicker, showing that the dynamic force cycle equals the static force cycle.

The second basic type of universal testing machine uses constant force instead of constant amplitude. In this system the force applied is constant, while the amplitude can vary if slippage occurs or the material modulus changes. Machines operating on this principle use an eccentric mass spinning in space to generate the force.

A typical testing unit is shown in Fig. 6. The eccentric mass is rotated at constant speed by the synchronous motor. The sinusoidal force is transmitted to the vibrating platen.

The force is adjusted by varying the unbalance or eccentricity, since the mass rotates at a constant speed. The eccentric consists of a heavy mass on one end of a threaded rod. The thread is chosen so that one turn of the screw represents 20 lb of force when the eccentric is at its operating speed. The circumference of the cylindrical weight is calibrated in ten equal divisions with each division representing 2 lb of force. The result is a micrometer adjustment where the linear scale reads full turns at 20 lb per turn and the spindle reads tenths of a turn or 2 lb increments. A brass plug and thumbscrew act as a clamp, and a snap ring prevents the eccentric from accidently becoming unscrewed during service. Other size machines use the same arrangement with different size eccentrics and scale values.

The static preload is applied by compressing the preload springs by means of the screw jack. The dial indicator reads spring deflection in thousandths of an inch. By combining static and dynamic loads all stress conditions from 100 percent reversed load to unidirectional loading can be obtained.

All but the smaller machines use power driven screw jack to apply the preload. Power screws, driven by a gear motor, engage preloaded split nuts to compress the springs. An electronic controller senses the mean position of the vibrations and acts to maintain the preset condition when creep occurs.

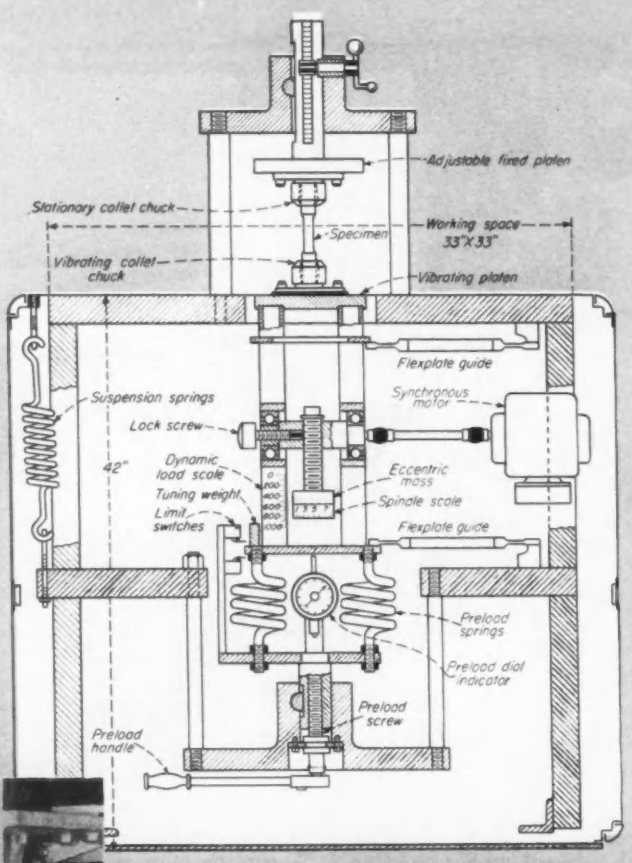
The entire operating mechanism of the machine, Fig. 6, is mounted on suspension springs. These act as vibration isolators and give a seismic suspension. No special foundations are required and the machine can be mounted wherever desired.

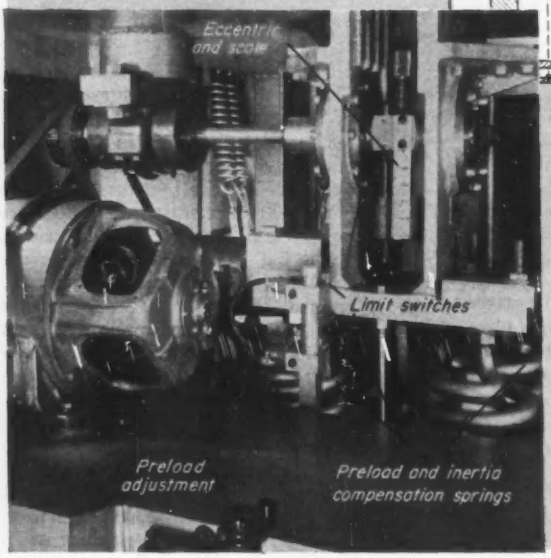
The guides which support the eccentric mass mechanism and vibrating platen are flexplates.

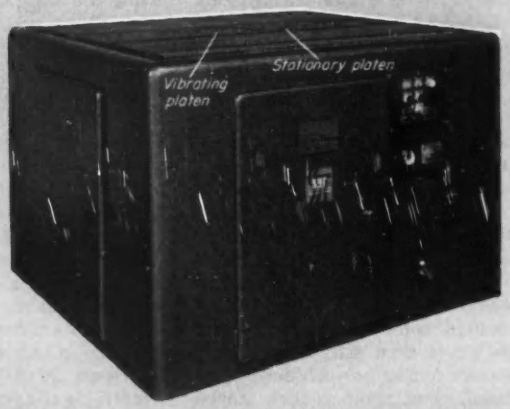
In Fig. 7 is shown exterior and interior views of a commercial machine of the rotating eccentric type. The preload adjustment is the manual selector for the electronic preload control. The required spring deflection is dialed on the indicator, and a power

Fig. 6—(Right) Constant force universal fatigue tester. Force is generated by eccentric mass rotating at a constant speed and is controlled by varying eccentricity. Preload is applied by compressing preload springs. The dynamic load scale and spindle scale are calibrated to read maximum dynamic force. The dial indicator reads spring deflection and consequently preload force. This machine is preloaded manually.

Fig. 7—(Below) Exterior and interior views of 10,000 lb constant force machine. This type machine will handle a wide variety of specimens since the fixed platen can be adapted to suit. The drive motor runs at a constant speed so that it is possible to compensate for the inertia forces. Tuning weights are added to the vibrating mass until the inertia force at various amplitudes just equals the spring force at the same amplitude. Under this condition, the specimen is only subjected to the controlled force generated by the eccentric mass and is not effected by inertia forces.







follow-up automatically deflects the springs the proper amount.

An important feature of this machine is the method of compensating for inertia forces. The preload springs are selected, and the mass of the vibrating parts adjusted, so that the inertia force at various amplitudes just equals the spring force at the same amplitude. This is possible since the drive operates at constant speed. The spring force is directly proportional to the deflection and at a fixed speed the inertia forces are proportional to amplitude. With the spring force and inertia force equal, the two forces cancel, leaving only the eccentric force acting on the specimen. In practice, weights are added or removed from the vibrating platen until a resonant condition is obtained. This is done without the specimen in place. When tuned, the unknown inertia force is balanced out and the accuracy of the applied force can be maintained over the full range.

Editor's Note: Part II of this article will be published in the March issue of *Product Engineering*. It will cover the resonant type of universal machine, semi-special machines, and vibration generators or oscillators.

Design Features of 1953 Cars

THE major factor influencing the design of 1953 automobiles is the sales picture. Auto manufacturers expect this year to mark a return to an era of hard selling and reticent purchasers, so they've aimed their 1953 models at overcoming sales resistance and meeting competition.

In engineering, there are only two major innovations: automotive air conditioning, and a return to 12 v ignition systems. Other design changes substantiate or improve trends started in previous years. Here is a brief look at how they affect design:

Engines. Auto makers have started a hot horsepower race. Practically every model boasts increased engine rating—even, as in Plymouth's case, when the increase is only 3 hp (notable exceptions: Chrysler and DeSoto). Top honors for this year go to Cadillac (210 hp) and Lincoln (205).

Public indignation over increased horsepower has Detroit worried. Auto makers point out that more power doesn't necessarily have to mean higher accident rates. They claim that souped-up engines also provide better performance, more economical operation, and more comfortable riding. Biggest fear is that government, state or federal, will step in and legislate a limit for engines.

Other more palatable suggestions include: (1) a gentleman's agreement among manufacturers not to exceed certain limits and to soft pedal horsepower advertising; (2) a standardization program to be developed by the Society of Automotive Engineers.

The usual method to increase horsepower boosts compression ratio and increases engine speed. This introduces an ignition problem. As compression ratios increase, pressures in the engine combustion chamber also increase, so that the spark plugs require a higher voltage to permit the spark to jump across the gap. Limiting factor is the time available to build up voltage. High speed engine operation, tends to reduce the amount of time available.

Two years ago Chrysler started using a double breaker distributer to extend the voltage-building-up time. This year General Motors will introduce twelve volt ignition systems on the Cadillac, Buick and Oldsmobile. Time to build up the voltage to necessary peak is reduced because the base voltage is increased 100 percent.

New engine designs indicate that V-shaped engines are reaching new popularity. Last year DeSoto joined Ford (8 cylinder), Lincoln and Oldsmobile with a V-design. This year, you can add Dodge and Buick.

Along with the V-design has come a trend to rectangular engines in which the bore exceeds the stroke. Main advantages include reduced friction because of reduced piston travel, and more compact engines. Also many companies have boosted the speed rating of their power plants.

Mechanically, the higher horsepower has dictated sturdier engine design. To accommodate the power and higher speeds, designers have had to beef-up crankshafts, pistons, crankcases, bearings, lubrication systems, and cooling systems.

Accessories. Public acceptance of automatic transmissions has encouraged manufacturers to improve performance. Usual step taken: redesign the unit so that stalled torque ratio is increased, and stall speed is reduced.

When automatic transmissions made their initial appearance, stall speeds ranged from 2,400 to 2,800 rpm. That meant you had to accelerate the engine to high speed before you started to get any pull when you were starting from a stop. This year, Packard's Ultramatic is rated with a stall speed of only 1,400 rpm, Buick is down to 1,800, other units are also lower than previous models.

The newest accessory is air conditioning. General Motors made the first announcement for Cadillac, Buick and Oldsmobile; Chrysler and Packard quickly followed suit. While details vary, all the systems are similar: compressors are directly connected to the engine and run whenever the engine operates. Condensers are mounted in front of the radiator and the evaporator and air handling fan are located in the trunk compartment.

Styling. Most manufacturers are playing up consumer approval of continental styling. The result: sportier models throughout the industry.

LINCOLN: Revs Up to 205 Horsepower

Lincoln Capri

THE FACT that idle vacuum was increased from 16 to 17.5 in. Hg in '53 while boosting bhp rating from 160 hp to the present level indicates the degree of performance of the new Lincoln engine over the entire speed range. Specific fuel consumption is down 20 to 25 percent. The same engine is available in the Cosmopolitan series, which include a sport coupe and four door sedan, and the Capri sedan, convertible, or hardtop shown here.

ENGINE SPECIFICATION

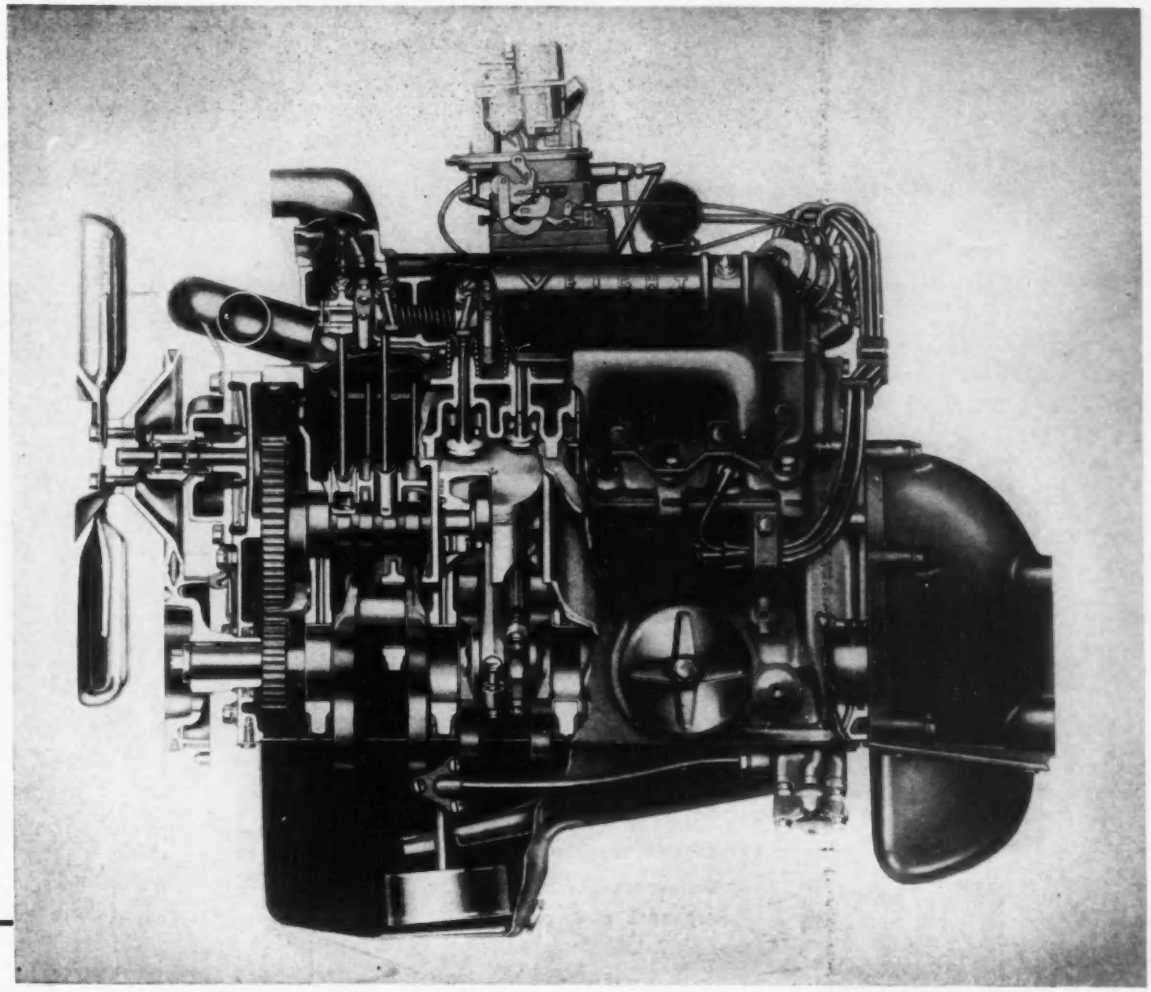
	1952	1953
Intake Manifold Runners	1.56 sq. in.	1.80 sq. in.
Intake Valve Diameter	1.74 in.	1.98 in.
Intake Valve Lift	0.3375 in.	0.3545 in.
Compression Ratio	7.5 to 1	8.0 to 1
Idle Vacuum	16 in. Hg	17.5 in. Hg
Bore	3.8 in.	3.8 in.
Stroke	3.5 in.	3.5 in.
Total Piston Displacement	317 cu. in.	317 cu. in.
Engine Torque, max.	284 ft-lb	305 ft-lb
Carburetor	2-barrel	4-barrel
Horsepower, bhp max.	160 at 3,900 rpm	205 at 4,200 rpm

For 1953 Lincoln engineers have concentrated on engine changes designed to provide sports car performance in the luxury car field. Power steering, power braking, and a 4-way power adjusted front seat have been developed as optional equipment but the big change is in the 205 bhp engine that will accelerate a standard stock model from stand still to 80 mph in 22 sec and push it along at 112 mph for sustained periods.

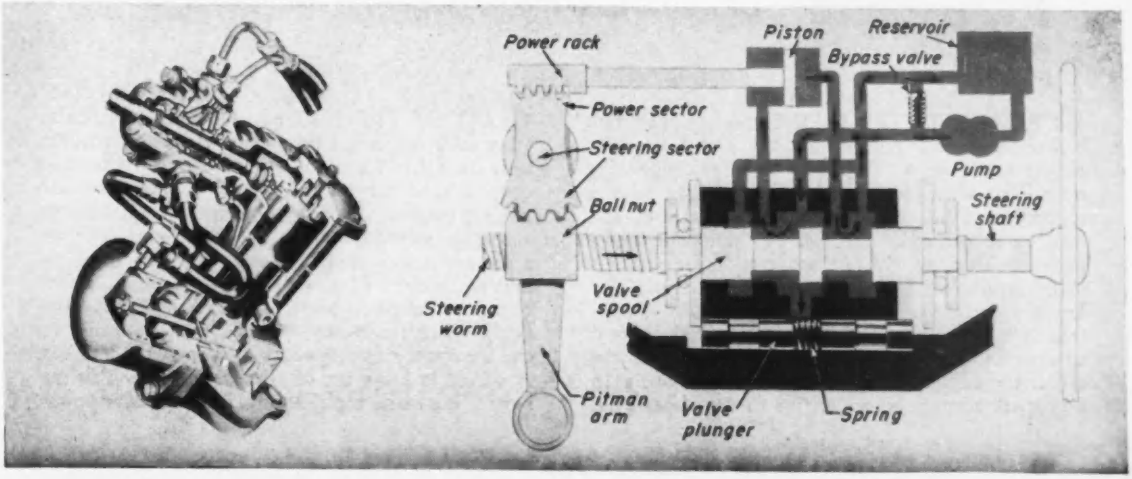
Actually the basic engine is the same as in '52 models. Bore and stroke and hence piston displacement are identical. The additional 45 hp has been obtained by: (1) increasing engine torque from 284 to 305 ft-lb, largely by redesigning the head to get a compression ratio of 8:1; and (2) increasing air-fuel volume to the cylinders through the addition of a four-barrel carburetor, larger intake manifold, larger inlet valves, higher valve lift, and a new exhaust system including manifold, thus allowing the engine to be rated at 4,200 instead of 3,900 rpm as formerly.

Other changes, such as redesigned camshaft which was introduced late in '52, and a higher turbulence combustion chamber also contributed to improved performance.

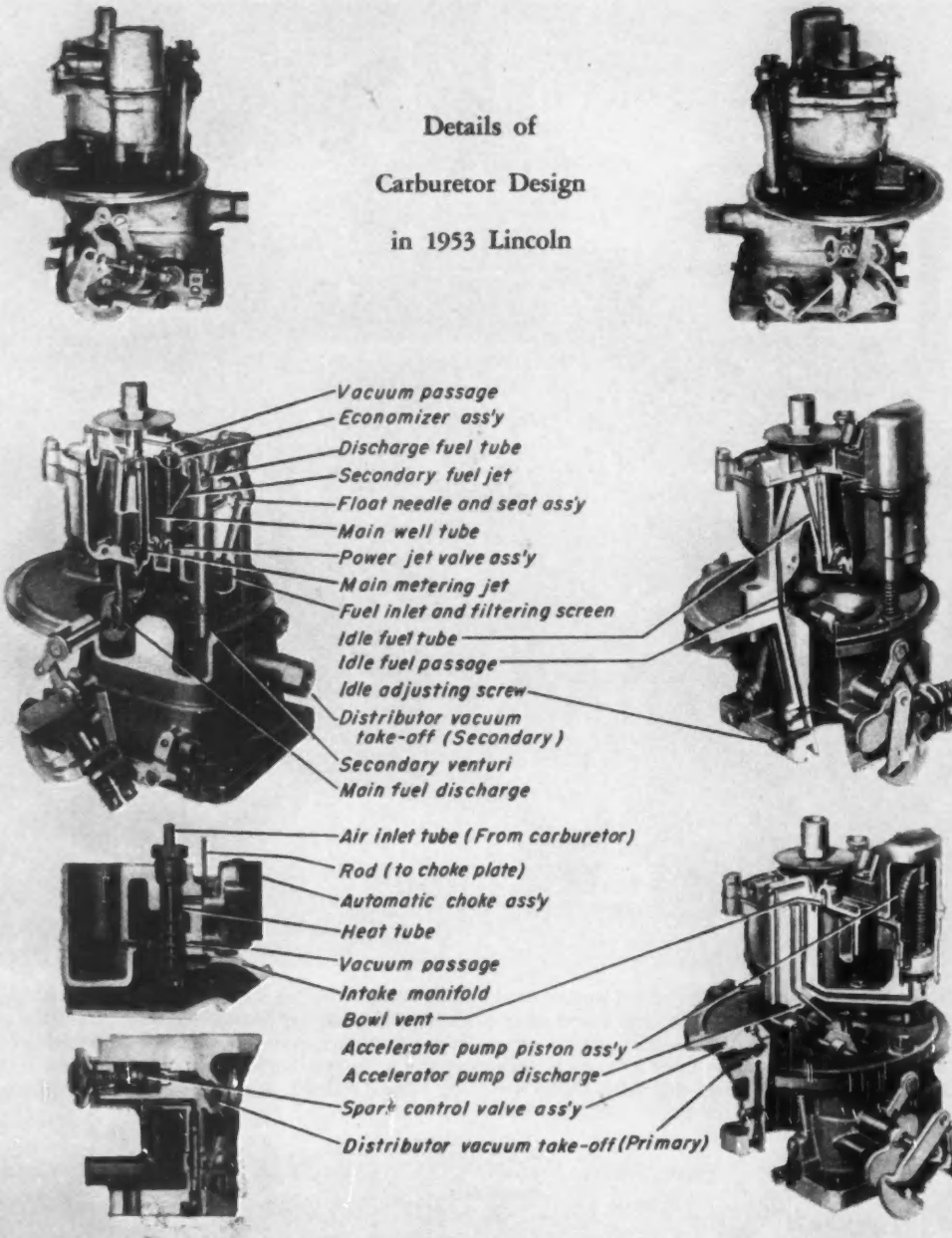
POWER STEERING, offered as optional equipment, is operated by an Eaton rotary gear pump (shown in insert) that is belt driven from the crankshaft at 1.76 engine speed. It develops a maximum pressure of 750 psi to supply power to the hydraulic cylinder in the steering gear which takes over when ever rim pull on the steering wheel exceeds 4 pounds. When this occurs, rotating the wheel causes the steering column to move axially on a recirculating ball nut. At the extreme position, flow is as shown. When the column is in the central position, flow is equally bypassed on both sides of the center spool and pressure on each side of the piston is equalized. The valve plungers, bottom, provide built-in resistance and thus "feel" since pressure on the spring side must be overcome before power steering takes effect.



INCREASING the compression ratio to 8:1 necessitated several engine modifications to keep the combustion chamber and spark plug clean under the higher engine pressures. Expander type oil rings and rubber valve stem seals that prevent oil from running down the valve guides are the methods used to improve oil economy. Modifying the combustion chamber promotes greater turbulence and therefore—Lincoln claims—substantially better efficiency. Principal engine specifications for '53 vs '52 are indicated in the table (at left), note similar cylinder dimensions.

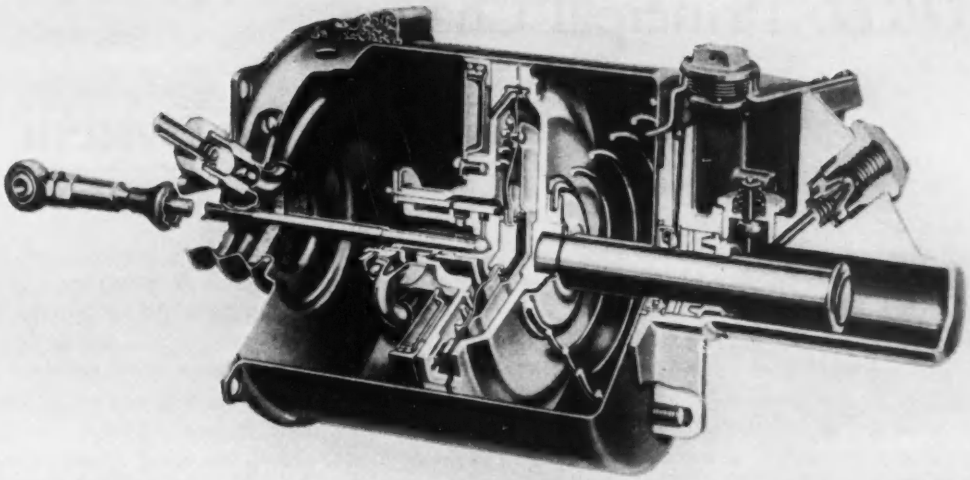


Details of Carburetor Design in 1953 Lincoln

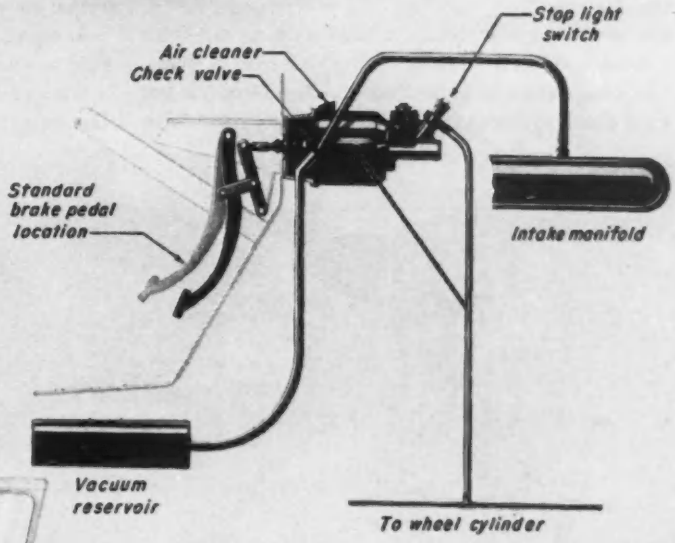


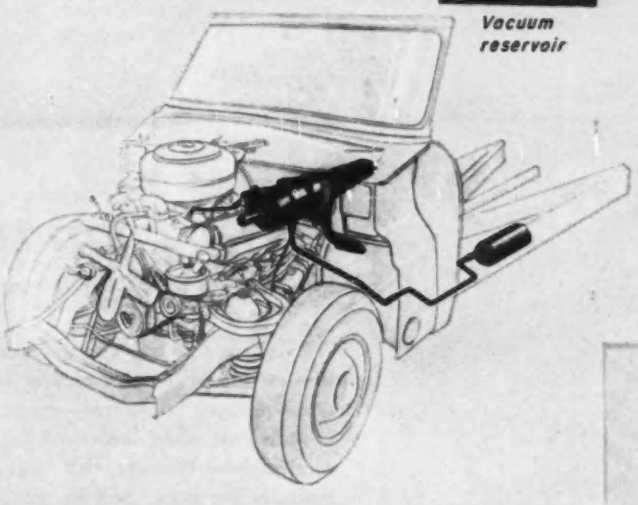
TO PERMIT BETTER IDLING performance, two carburetor adjustments are provided. One is used for proper setting on a cold engine with the choke wide open. The other, for a closed choke condition, adjusts to prevent a fast idle at normal temperatures and consequent car creep through the automatic transmission. Then, to get fast acceleration from standstill—Excecutive Engine Engineer Vic Raviolo and Lincoln-Mercury car engineer Neil Blume like to refer to it as "extra wallop"—the linkage of the distributor advance is tied through a push-pull cable to the carburetor acceleration lever. This gives about a 15 deg. spark advance before engine vacuum takes over.

HEART OF THE ENGINE is a four-barrel carburetor with suspended float bowl. At idling position, only the valves for the first stage barrels are partially open. Immediately off idle, the valves for the rear barrels are cracked, at which point they remain until the first stage valves are about 75 percent open. The second stage barrels are then brought into action by connecting linkage. Also, with the choke (reverse side) open, an interlock prevents the rear barrels from being brought into play, but as the engine warms up and the choke cam drops back to normal, the interlock is shifted to allow use of all four barrels. This carburetor is a major contributor to increased horsepower.



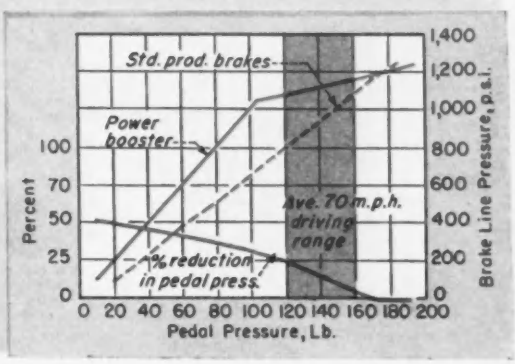
HOW BRAKNG SYSTEM OPERATES. Pressure on the brake pedal moves the brake rod forward. This action closes off the atmosphere inlet and opens the manifold port, which applies manifold pressure to the forward end of the booster cylinder. Atmospheric pressure on the reverse side forces the booster cylinder forward. Since the area ratio of the booster piston to the hydraulic piston is large, the latter is forced forward and pressure is transmitted from the master cylinder to the brake cylinders. Pedal travel is reduced 50 percent thus allowing the height of the brake pedal to be made the same as that of the accelerator treadle.





SCHEMATIC of the power braking system. Mounted on the engine side of the firewall directly ahead of the driver, vacuum booster is connected to the engine manifold for its vacuum source.

EFFECT of power braking on reduction in pedal pressure. However, principal advantage is that for equal pedal pressure, brake line pressure is greatly amplified.



FORD: Principal Change

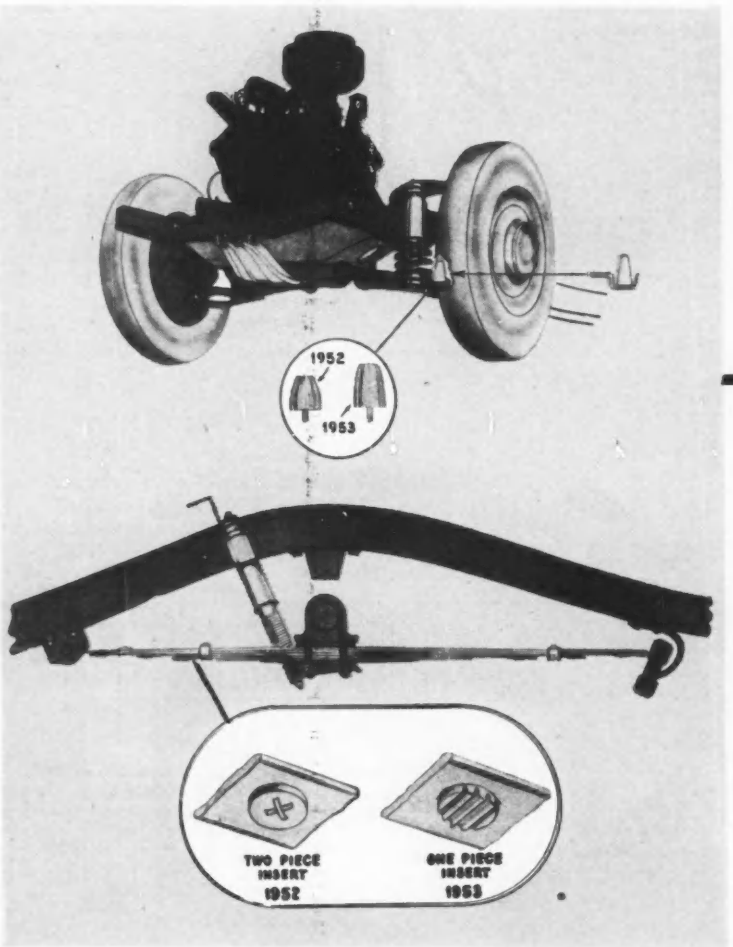
Is in the Suspension System

A redesigned suspension system plus minor body and trim modifications have been made for Ford's 50th Anniversary line. Compared to Model T days when the customer could get any color he wanted as long as it was black, this year there are in all more than 200 body-style, color, and upholstery combinations; two engine choices in the 101 hp overhead valve six and the 110 hp V-8; and either conventional, overdrive, or automatic transmissions.

The new suspension system reduces pitching and front end shock and "strike-through" on rough road surfaces. A 2 in. bump when hit at medium speeds transmits a 300 lb road shock to the chassis, as compared to 1,500 lb in last year's model. Too, rear springs are refined.

Late production changes in the '52 models that will be carried over for '53 include, in the six cylinder engine, water pump redesign, a change in grommeting on the head gaskets, and larger water inlet and outlet in the block to improve cooling; and in the V-8, the addition of stiffening ribs to the oil pan and minor modifications in the muffler to reduce low speed resonance with the torque converter drive.

At right, you can see the styling changes in the 1953 Ford as compared to the 1952 model. Major changes are in front and rear ends. The single spinner front end carries a suggestion of previous Mercurys.



HOW the suspension system was modified. In the front, larger compression bumpers and new mounting plates, recalibrated shock absorber and higher capacity rubber insulators, plus a ribbed skid plate provide a softer ride and add front end chassis protection; in the rear, recalibrated shock absorbers, a lower spring rate, and new fabric spring insulators have been added. Ford continues to be a big user of accoustic materials to provide quieter car and engine operation.

MERCURY:

Except for styling changes and a new exhaust system that reduces back pressure about 50 percent—resulting in more rear wheel thrust and better acceleration—Mercury this year is basically the same. A 2 in. straight through tail pipe and a straight through muffler have been substituted for the 1¾ in. tail pipe and three pass muffler used previously. The air cleaner also has been re-engineered to reduce breathing losses.

Breathes Easier

Engine rating remains the same: 125 hp at 3,800 rpm, with a 7.2 to 1 compression ratio and maximum torque output of 218 ft-lb at 1,700 to 2,200 rpm.

Keeping pace with other auto manufacturers, Mercury offers seven different models, 13 basic colors, and 26 two-tone combinations. Custom styled interiors come on all models. In all, there are 29 interior trim combinations available.

Mercury Monterey

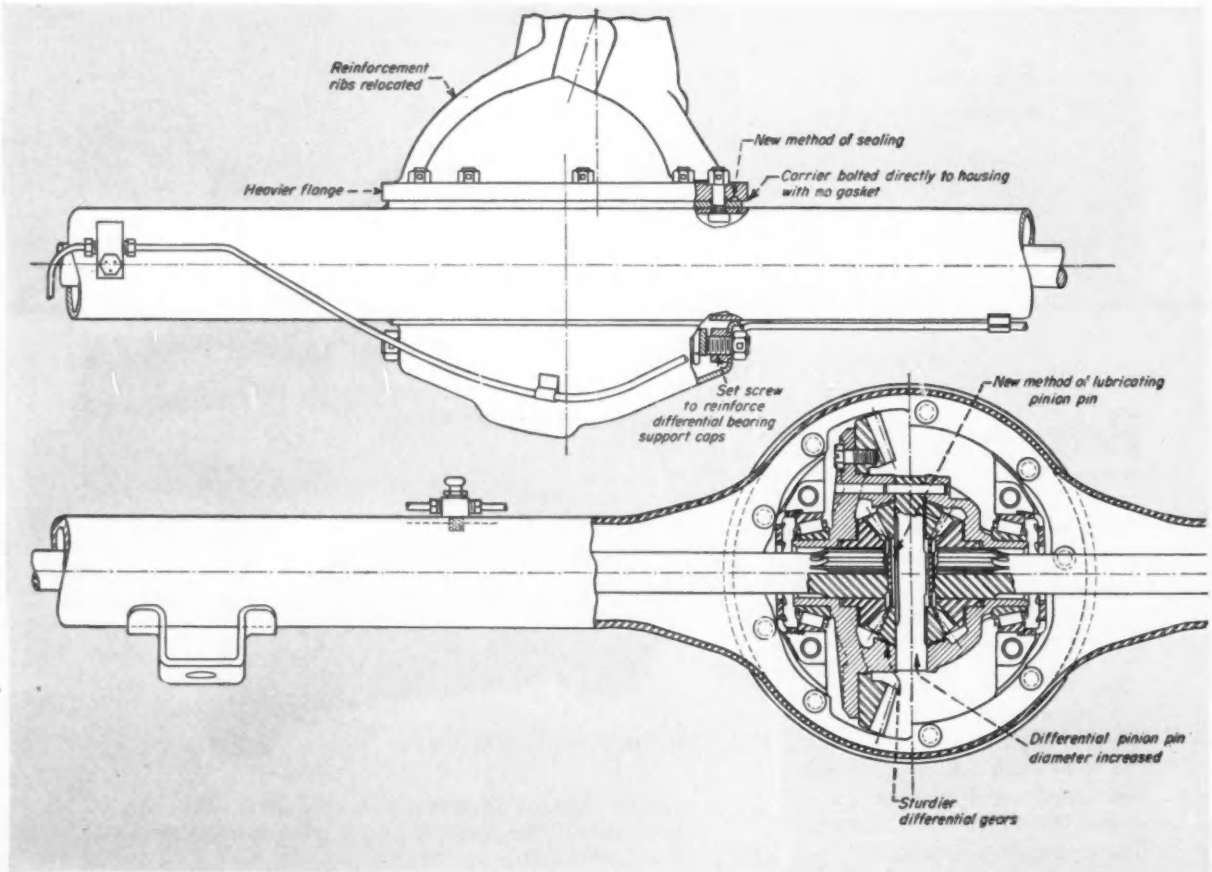
MAJOR STYLING CHANGES to give lower, wider appearance in the '53 Mercury include a new full length side moulding chrome wind-splits, and front end ornamentation.

PACKARD:

Packard Patrician

PACKARD REENTERS the prestige market with this Patrician four door sedan that has traditional low contour styling. Custom built versions are priced up to $6,900; Clipper models range from $2,500 to $2,800 without accessories.

STURDIER differential and rear axle indicate the effect of increased engine horsepower on chassis design. Note the large number of parts that were strengthened. In addition, Packard relocated reinforcement ribs so that they are in areas of high stress, changed load angle of pinion bearings from 30 to 40 degrees, and developed a new method of sealing the differential housing so that the carrier can use the housing for additional rigidity.


Reinforcement ribs relocated
New method of sealing
Carrier bolted directly to housing with no gasket
Heavier flange
Set screw to reinforce differential bearing support caps
New method of lubricating pinion pin
Differential pinion pin diameter increased
Sturdier differential gears

More Horsepower Means Major Changes

This year Packard aims for a bigger share of the 1953 automobile market with two distinct lines, the medium priced Clipper and a prestige Packard line.

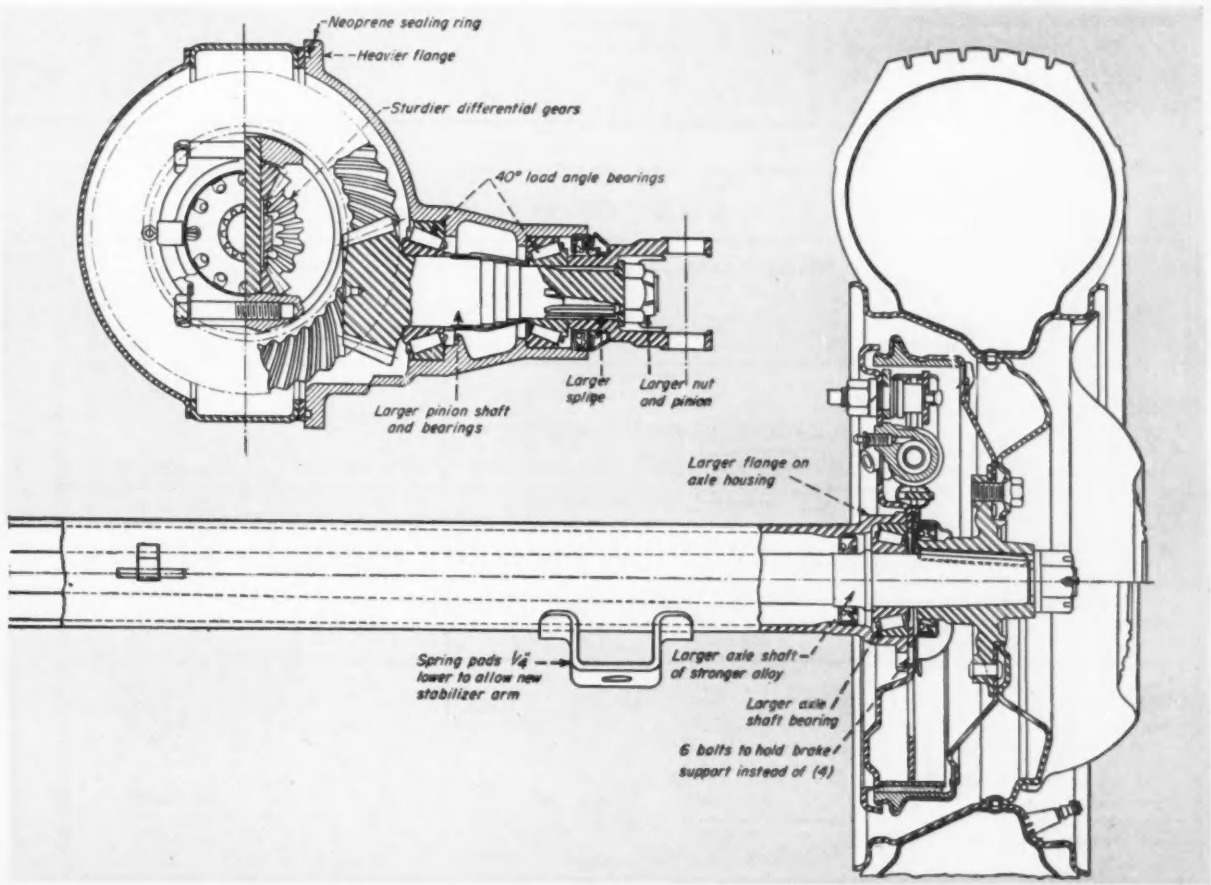
In the Packard line, engineers increased the compression ratio of the L-head eight cylinder engine to 8.0:1, redesigned the combustion chamber and added a four-barrel carburetor to boost rated output to 180 hp. Improved compression ratio boosts the rating of the Clipper engine to 150 hp, and the Clipper Deluxe to 160 hp.

Because of the increased engine horsepower, Packard redesigned the rear differential and rear axle. Still a hypoid gear type, the new differential is twice as sturdy as in previous models and has these innovations:

Sturdier reinforcing ribs have been relocated from low stress areas to high stress areas. A new method of sealing the housing eliminates the gasket by using a neoprene ring that permits bolting the carrier directly to the housing for added rigidity. A new method of lubricating the differential pin, in which Packard mills a lubrication slot partway instead of along one entire side, prevents centrifugal force from throwing the lubricant out. Taper roller bearing angle has been changed from the conventional 30 deg to 40 deg to afford greater resistance to end thrust as the pinion gear tries to work out on acceleration or tends to be pulled in on deceleration.

Redesign of the Ultramatic automatic transmission and improved engine performance permits Packard to use a low rear axle ratio of 3.23:1 on the Clipper Deluxe to obtain better gasoline mileage. Major change in the transmission is in the first turbine where the shape, size and number of blades (from 28 to 22) have been changed to increase stall torque ratio from 2.4:1 to 2.55:1 while decreasing stall speed to about 1,400 rpm.

Highlight of the new front suspension system are new rubber bushings which insulate the suspension from the frame, and dampen out road noise and shock which is

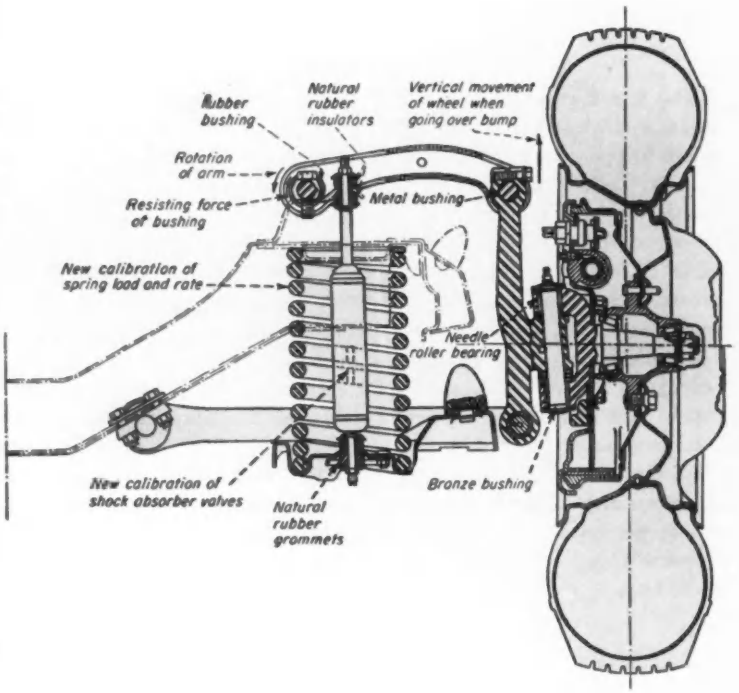

Neoprene sealing ring
Heavier flange
Sturdier differential gears
40° load angle bearings
Larger spline
Larger nut and pinion
Larger pinion shaft and bearings
Larger flange on axle housing
Spring pads ¼" lower to allow new stabilizer arm
Larger axle shaft of stronger alloy
Larger axle shaft bearing
6 bolts to hold brake support instead of (4)

ordinarily transmitted to the chassis.

As optional special equipment, Packard offers a hydraulic power steering that puts the power cylinder on the connecting rod instead of on the steering chuck. In this system there are only four elements: a matched-set rotor-type pump and reservoir, hydraulic lines, one spool-type control valve, and a movable power cylinder whose piston rod is fixed to the car frame. With power steering, the steering knuckle pin is mounted on needle roller bearings, top and bottom, for easier steering.

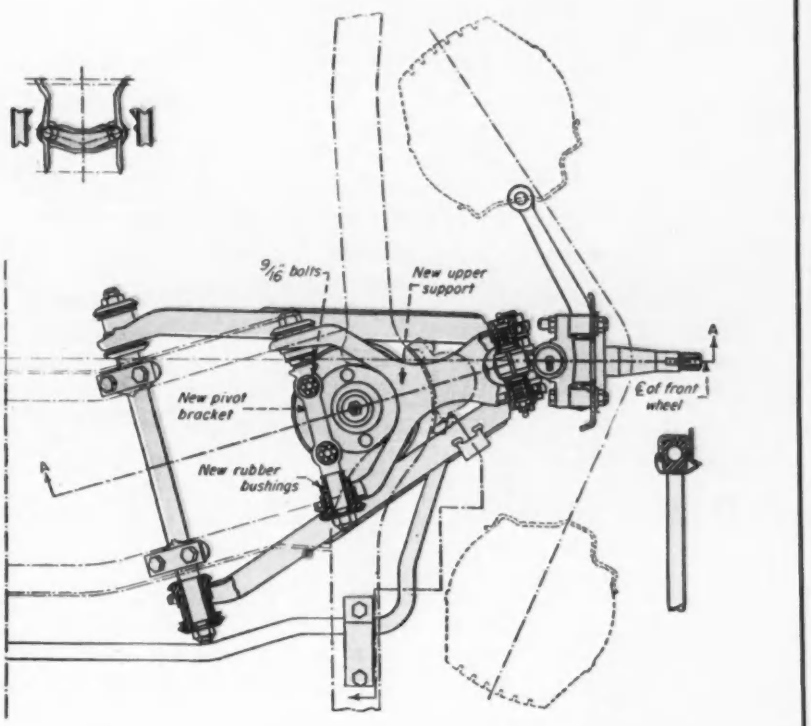
While Packard power steering reduces the effort required to turn the steering wheel by 80 percent, the driver retains feel of the road through calibrated reaction oil pressure acting on the outer end of the spool valve which is directly linked to the pitman arm. The system is combined with conventional steering gear so that the driver can maintain control of the car in case of a hydraulic power failure.

In styling, new bumper lines and a restyled rear end make the 1953 Packard appear lower and longer.



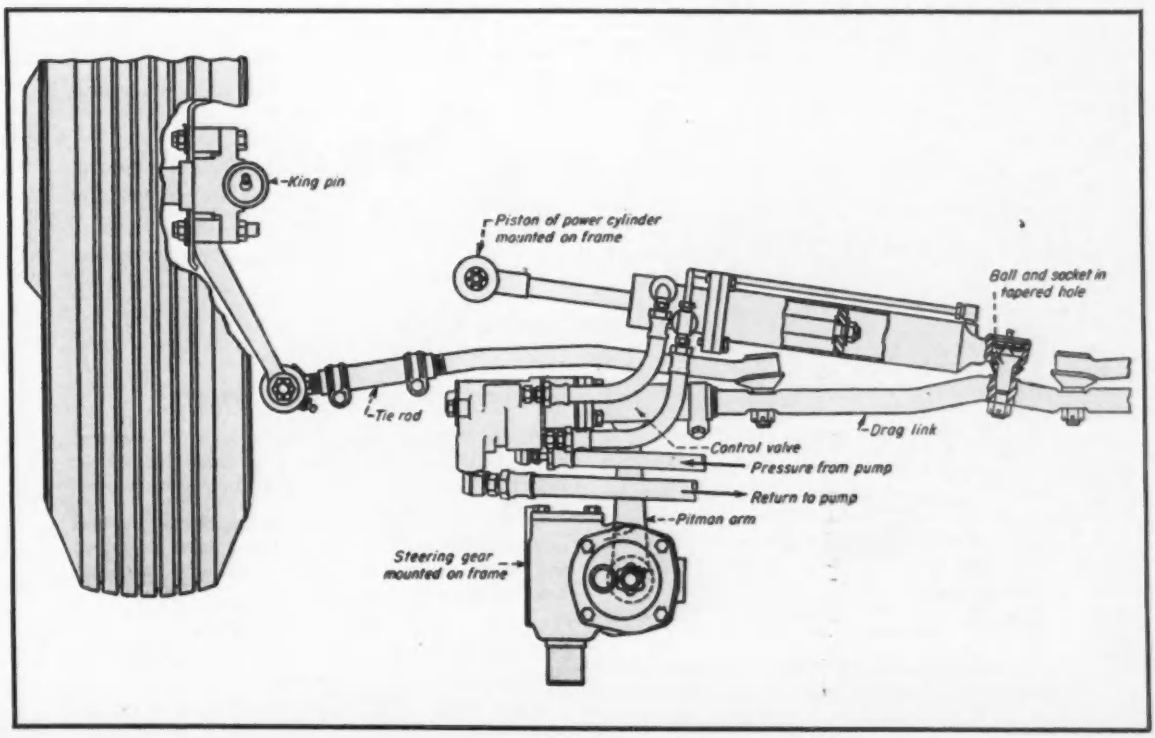
SPECIFICATIONS

	THE PACKARD LINE			THE CLIPPER LINE	
	300 (4-door sedan)	300 (4-door sedan)	Hardtop and Convertible	Deluxe Clipper (2-door and 4-door sedan)	Clipper (2-door and 4-door sedan)
ENGINE					
Type	L-HEAD, EIGHT CYLINDERS IN LINE				
Brake Horsepower	180 at 4,000 RPM	180 at 4,000 RPM	180 at 4,000 RPM	160 at 3,600 RPM	150 at 4,000 RPM
Displacement	327 cu. in.	327 cu. in.	327 cu. in.	327 cu. in.	288 cu. in.
Bore and Stroke	3½" x 4¼"	3½" x 4¼"	3½" x 4¼"	3½" x 4¼"	3½" x 3¾"
Compression Ratio	8 to 1	8 to 1	8 to 1	8 to 1	7.7 to 1
Carburetor	4 barrel down-draft	4 barrel down-draft	4 barrel down-draft	dual down-draft	dual down-draft
DIMENSIONS					
Wheelbase	127"	127"	122"	122"	122"
Length	218-5/32"	218-5/32"	213-5/32"	213-3/32"	213-3/32"
Height — overall	62-29/32"	62-29/32"	62"	62-11/16"	62-11/16"
Width — overall	77-7/8"	77-7/8"	77-7/8"	77-7/8"	77-7/8"



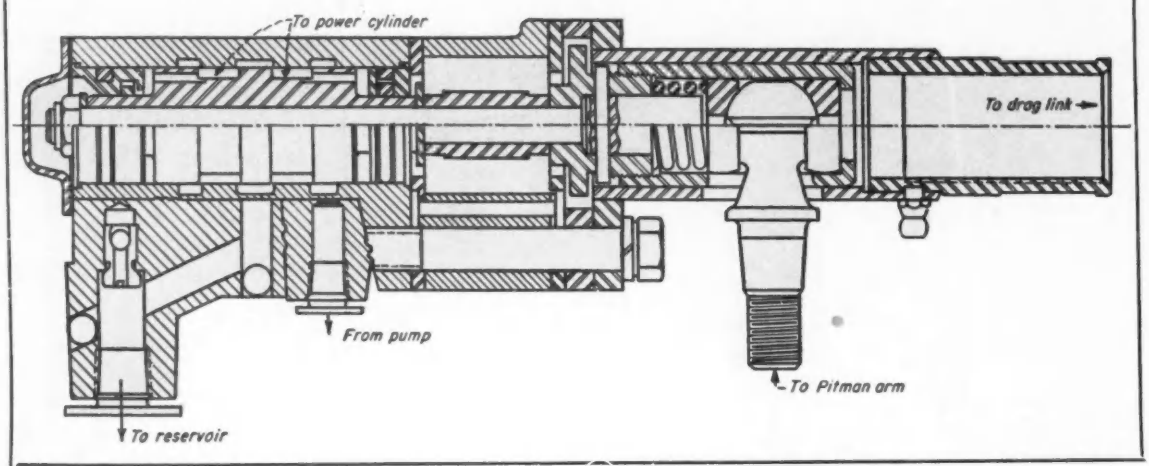
NEW PARALLELOGRAM front suspension: rubber bushing insulates suspension from car chassis. Eccentric threaded pin and metal bushings are retained to avoid complication in caster and camber adjustments. Shock absorber rubber insulators also cushion road irregularities from the chassis. Extensive use of natural rubber permits better calibration of springs and shock absorber. Note how suspension system has been modified for higher horsepower: the use of needle roller bearings, heavier bolts, more rugged pivot braces, new upper bracket, etc.

MOVING POWER cylinder (below) is mounted directly on steering connecting rod by ball and socket in tapered hole. Cross member of frame protects it against dirt, slush, etc. Pitman arm operates control valve for power steering and drag link for conventional steering in case of hydraulic power failure.

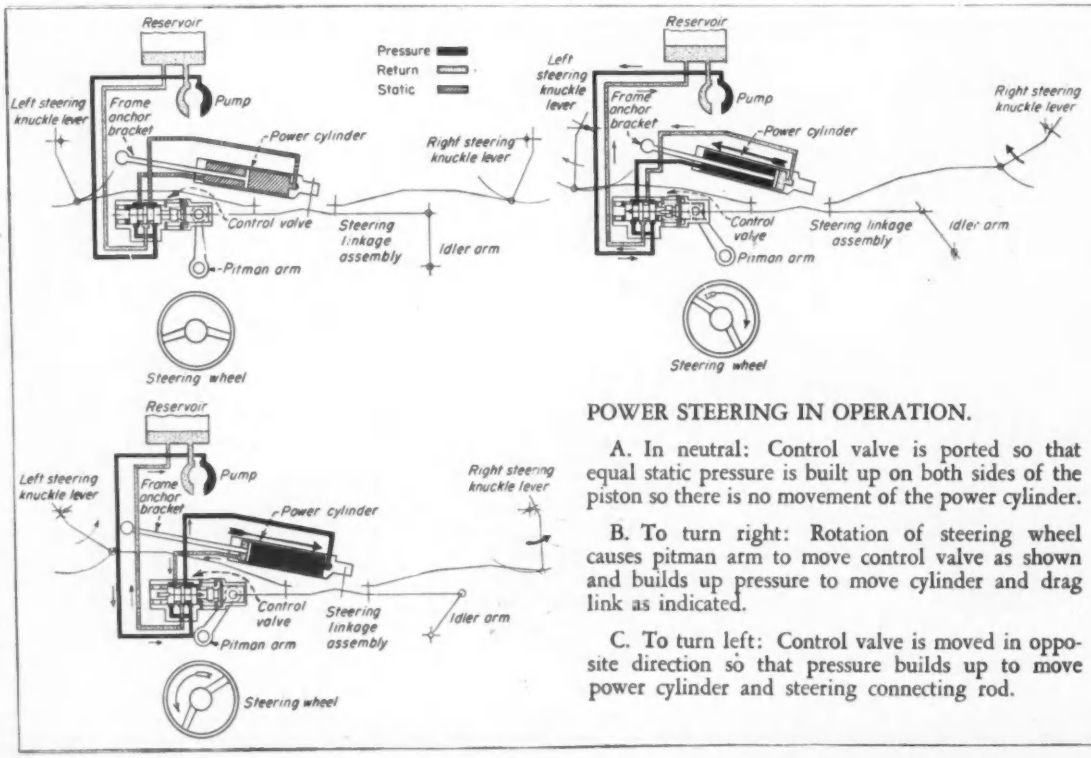


Effect of Packard Power Steering

Model	POWER STEERING		CONVENTIONAL STEERING	
	Steering gear Ratio	Steering wheel Turns	Steering gear Ratio	Steering wheel Turns
Packard Clipper and Deluxe	22.5:1	4	27.8:1	4-3/8
Packard 300 and 400	22.5:1	4	30.4:1	4-3/4



HEART of this power steering system is the spool-type control valve connected directly to the pitman arm. In neutral position (as shown) all passages in control valve are interconnected by position of the lands of the spool valve. This permits the hydraulic pressure to bypass back to the reservoir and pumps.



POWER STEERING IN OPERATION.

A. In neutral: Control valve is ported so that equal static pressure is built up on both sides of the piston so there is no movement of the power cylinder.

B. To turn right: Rotation of steering wheel causes pitman arm to move control valve as shown and builds up pressure to move cylinder and drag link as indicated.

C. To turn left: Control valve is moved in opposite direction so that pressure builds up to move power cylinder and steering connecting rod.

Kaiser Manhattan

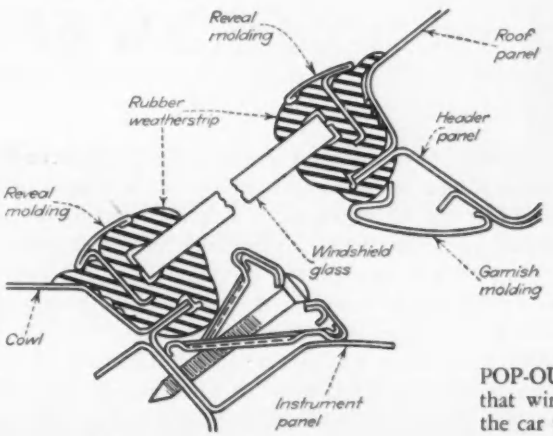
KAISER:

Puts Emphasis On Luxury Styling

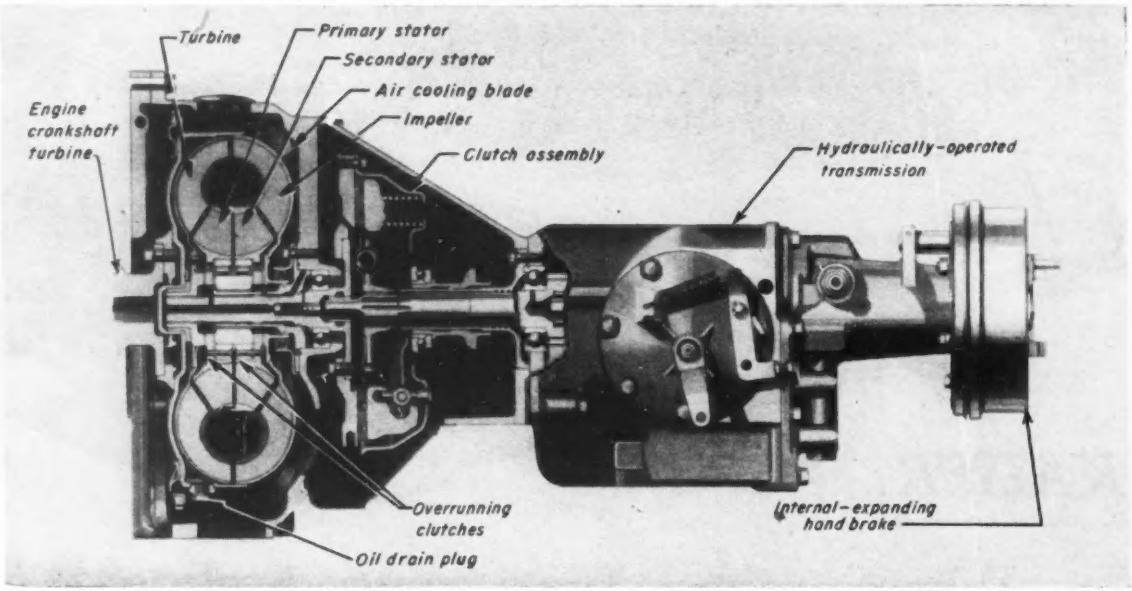
Using last year's basic body styling, Kaiser-Frazer Corporation has concentrated on improving safety, luxury and convenience features in the 1953 Kaiser. Among the changes are:

- New manifold, muffler, and exhaust assembly that boosts performance of the Kaiser six cylinder in-line engine from 115 to 118 hp with a maximum torque of 200 ft-lb at 1,800 rpm.
- Cushioned instrument panel crash pad and a "pop-out" windshield to provide greater safety for front seat occupants.
- Waterproof ignition cables and molded rubber spark plug caps for all-weather driving.
- Silicone lubrication for all door locks provide permanent lubrication.
- Illuminated trunk compartment with concealed tire well to increase carrying capacity.

COUNTER-BALANCED HINGES position trunk lid securely at any point from closed to fully open. Concealed spare tire well in trunk compartments increases available load carrying space and is reached by lifting ring on top cover. Compartment is illuminated by dual lamps. In styling Kaiser uses a low belt line and hoodline, emphasized by chrome moldings below the side and rear windows and on the rear fenders.



POP-OUT WINDSHIELD (left) is mounted in rubber so that windshield "gives" under severe impact from inside the car to reduce the danger of head injuries in accidents.



CHRYSLER FLUID-TORQUE DRIVE consists of torque converter and hydraulically operated transmission. Oil system is combined with that of the engine system, eliminating the torque converter oil pump and sump. Fluid is air cooled by blades on the outside of the torque converter shell.

Chrysler New Yorker

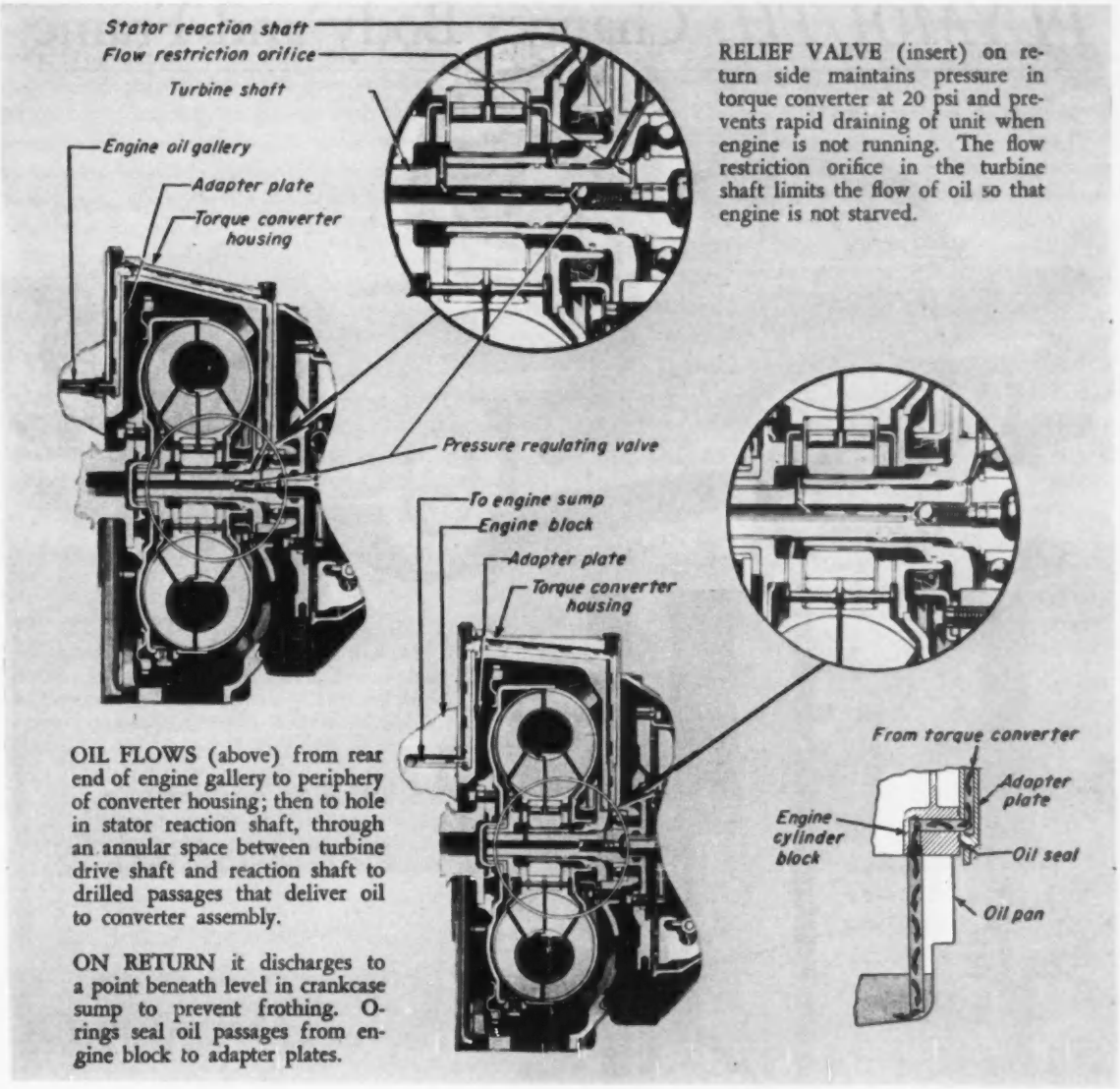
1953 CHRYSLER NEW YORKER deluxe sedan displays lines characteristic of all Chrysler models: long, low lines emphasized by carrying front fenders back through the doors and blending with the rear fender lines; long rear deck; and wide doors. All Chryslers are powered by the 180 hp Firepower V-8 engine except the Windsor line which is powered by the 119 hp Spitfire engine.

To meet competition, Chrysler will offer, as optional equipment, 12v electrical systems. On late '53 models, they plan to introduce a new power steering unit, redesigned for lightness and economy.

CHRYSLER:

Chrysler's new simplified torque converter features improved torque multiplication and its oil system is combined with that of the engine to simplify maintenance. An internal by-pass oil pump supplies both the engine and the torque converter, the latter at a rate of about two quarts per minute. Relief valves in the system prevent starving the engine at the expense of the converter.

The combined system uses a total of 13 quarts of oil. Chrysler employs a full flow oil filter and recommends changing the oil only twice a year. Torque multiplication is



RELIEF VALVE (insert) on return side maintains pressure in torque converter at 20 psi and prevents rapid draining of unit when engine is not running. The flow restriction orifice in the turbine shaft limits the flow of oil so that engine is not starved.

OIL FLOWS (above) from rear end of engine gallery to periphery of converter housing; then to hole in stator reaction shaft, through an annular space between turbine drive shaft and reaction shaft to drilled passages that deliver oil to converter assembly.

ON RETURN it discharges to a point beneath level in crankcase sump to prevent frothing. O-rings seal oil passages from engine block to adapter plates.

One Oil System for Engine and Converter

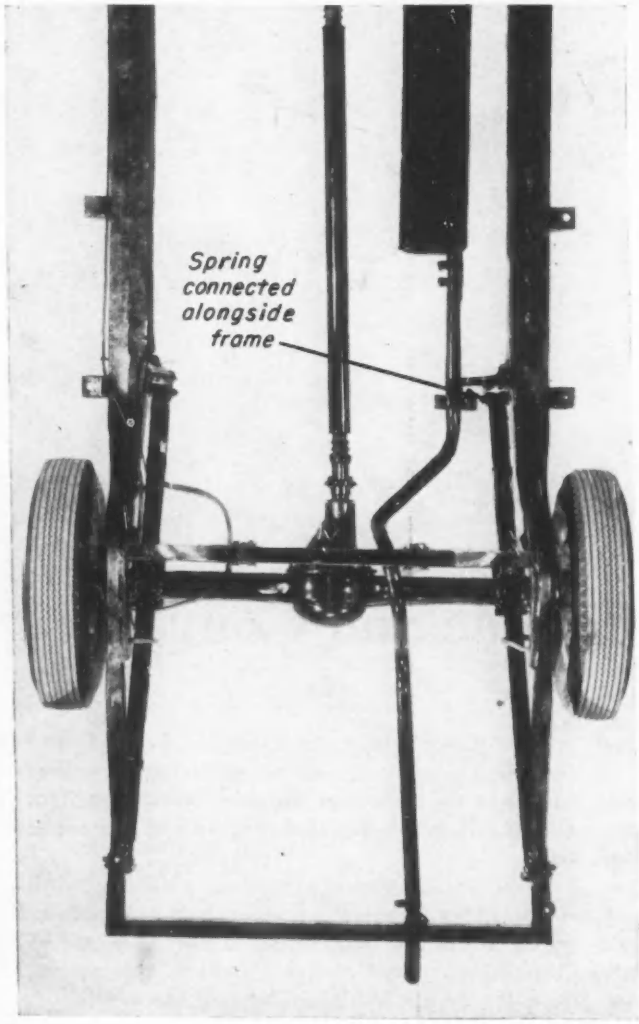
increased to 2.5:1 for improved starting and accelerating performance.

Chryslers new models have completely new bodies, styled for the prestige market with the same characteristic lines on all models—the 125½ in. wheelbase Windsor, Windsor Deluxe, New Yorker, and New Yorker Deluxe; the 133½ in. wheelbase Custom Imperial; and the 145½ in. wheelbase Crown Imperial. Body changes include the adaption of a one-piece wrap around windshield, "K"-type door outline, long rear deck and a new grille. Although front end styling retains traditional Chrysler lines for easy identification, long low lines have been established on the sides by carrying front fenders back so that they tend to blend with rear fender lines.

In the electrical system, a combination lighting switch and circuit breaker prevents complete failure of the lighting circuit due to a short circuit. Accessories offered by Chrysler, as optional equipment, include power steering, power brakes, and air conditioning.

PLYMOUTH: Changes Body and Frame

Plymouth Cranbrook



CHANGE IN FRAME SHAPE increases the angle of rise before the rear axle. Comparison with last year's design indicates amount of space saved without decreasing passenger space.

REAR SPRINGS are 12½ percent wider, are splayed inward, and relocated along the side of the frame. These features lower roll center of car and reduce pitching.

DE SOTO:

Since De Soto made extensive, major mechanical design changes in 1952, they've concentrated on body styling for 1953. Major innovation is the entirely new body that features swept-back fenders, wider and lower rear deck, and a massive front grille with parking lights located at the extreme edge under the headlights. Other styling notes: an increased glass area with a curved, one-piece wrap-around windshield; one-piece rear window; chrome fender moldings; and hidden center post.

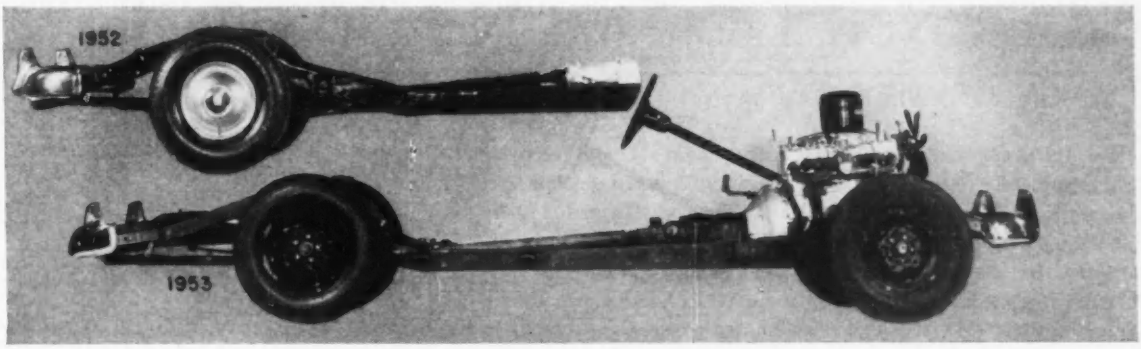
Most obvious change in the 1953 Plymouth is the new body. Plymouth engineers abandoned the previous basic body design that has been criticized as being "too much like a box", and restyled the car with these features: a lower belt line to increase glass area, curved windshield to increase visibility, and style lines that make the car look longer, lower, and wider, (though it is actually a fraction of an inch narrower than 1952 models).

To accommodate the new body, Plymouth redesigned the chassis and frame to make better use of available space. This major alteration involved changing the shape of the frame and redesigning the rear springs.

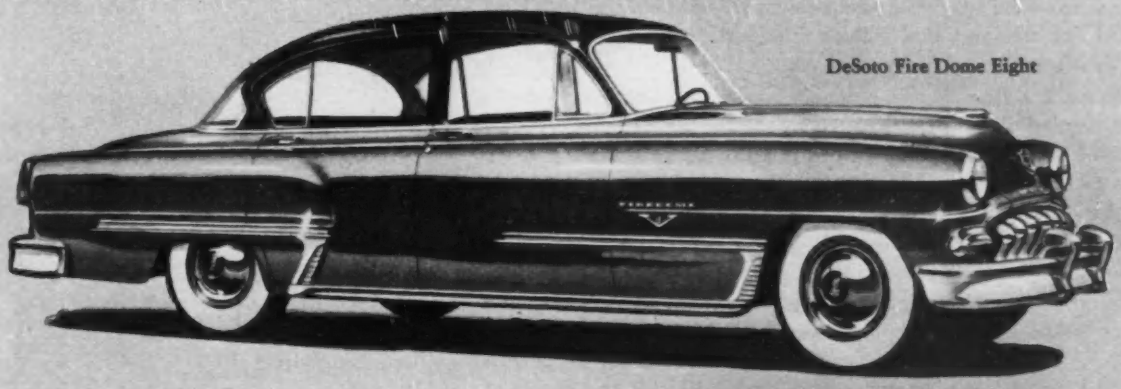
In the 1953 models, the engine has been moved forward. The frame is horizontal almost to the rear axle with the springs mounted along the side. This permits shortening the wheelbase to reduce overall weight, distributes the mass of the car more uniformly, and adds resistance to pitching of the car. Relocating the position of the upper control arms and splaying the rear springs inward helps to reduce roll of the car. The new frame design also provides 30 percent increase in luggage space.

Because of these changes, the '53 Plymouth has more headroom, greater legroom, and more hip and shoulder space than previous models. And at a time when many manufacturers are sacrificing these for lower styling.

Other changes in the new Plymouth include: For easier cold weather starting a starter drive with a lock on throw out mechanism that will not release until engine speed reaches 350-400 rpm (added to late 1952 models), increased engine rating from (97 to 100 hp) by boosting compression ratio from 7.0 to 7.1:1, quieter engine operation with a six bladed cooling fan running at 0.85 the speed of the engine instead of a four-bladed fan that ran faster than the engine.



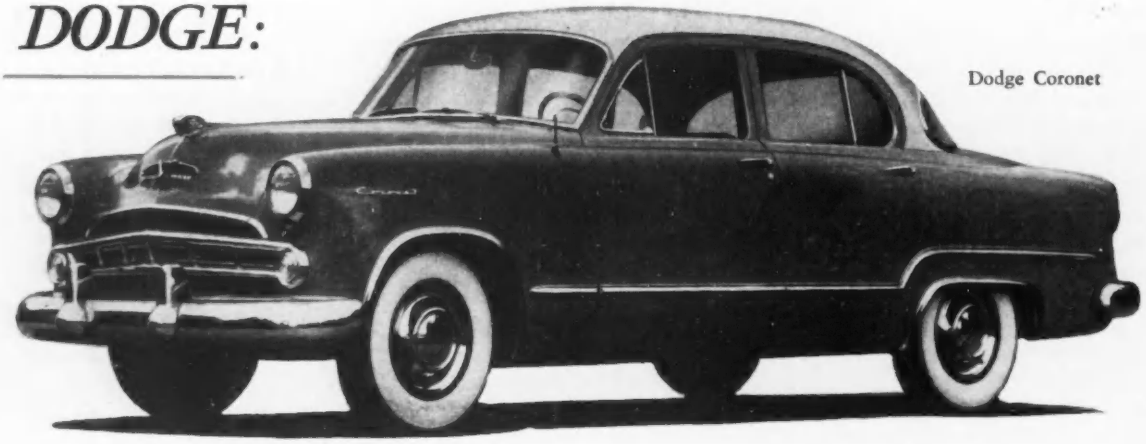
Stresses New Body Styling



DeSoto Fire Dome Eight

Mechanically, DeSoto will offer the 160 hp engine introduced last year, the same power steering and power brakes, and Chrysler's new torque converter that uses the same oil supply as the engine.

DODGE:



Dodge Coronet

Gets New Look and New V-8 Engine

For 1953, engineers at Chrysler Corporation's Dodge Division have completely restyled the Dodge body by increasing glass area and adding low continental lines. They developed a new 140 hp V-8 engine called the Red Ram, modeled on the hemispherical combustion chamber design already in use in Chrysler and De Soto automobiles. Other major features of the engine include square cylinder dimensions, lateral valve arrangement, and chain-drive camshaft.

Dodge chose this type combustion chamber because it has a low surface-volume ratio which reduces heat transfer and improves combustion efficiency. The spherical shape eliminates pockets or restrictions in the cylinder that might permit the formation of carbon deposits and hot spots, and allows the use of large valves to improve volumetric efficiency and valve cooling.

Laterally located in the chamber, the hydraulically lifted valves are stem-coated for initial scuff protection. Rocker arms with hardened tips are lubricated with an intermittent oil supply from the camshaft.

In the Red Ram engine, a double breaker distributor extends the time for building up the spark voltage to the higher value necessary to ignite the high pressure air-fuel mixture. By connecting two sets of braker points in parallel Dodge solved ignition problems caused by high engine pressures.

Other features of the new Dodge include: a new chassis and frame design (see Plymouth story, p. 150), centerbalance steering on Coronet models achieved by using equal length tie rods and a symmetrical idler arm which centers the linkage between the front wheels; increased hip and leg room and head room; 44 percent larger luggage compartment; one piece windshield; and choice of six different drive combinations including standard dry clutch transmission, standard dry clutch transmission with overdrive, automatic transmission with fluid coupling, and an automatic transmission with a four element torque converter and split stator.

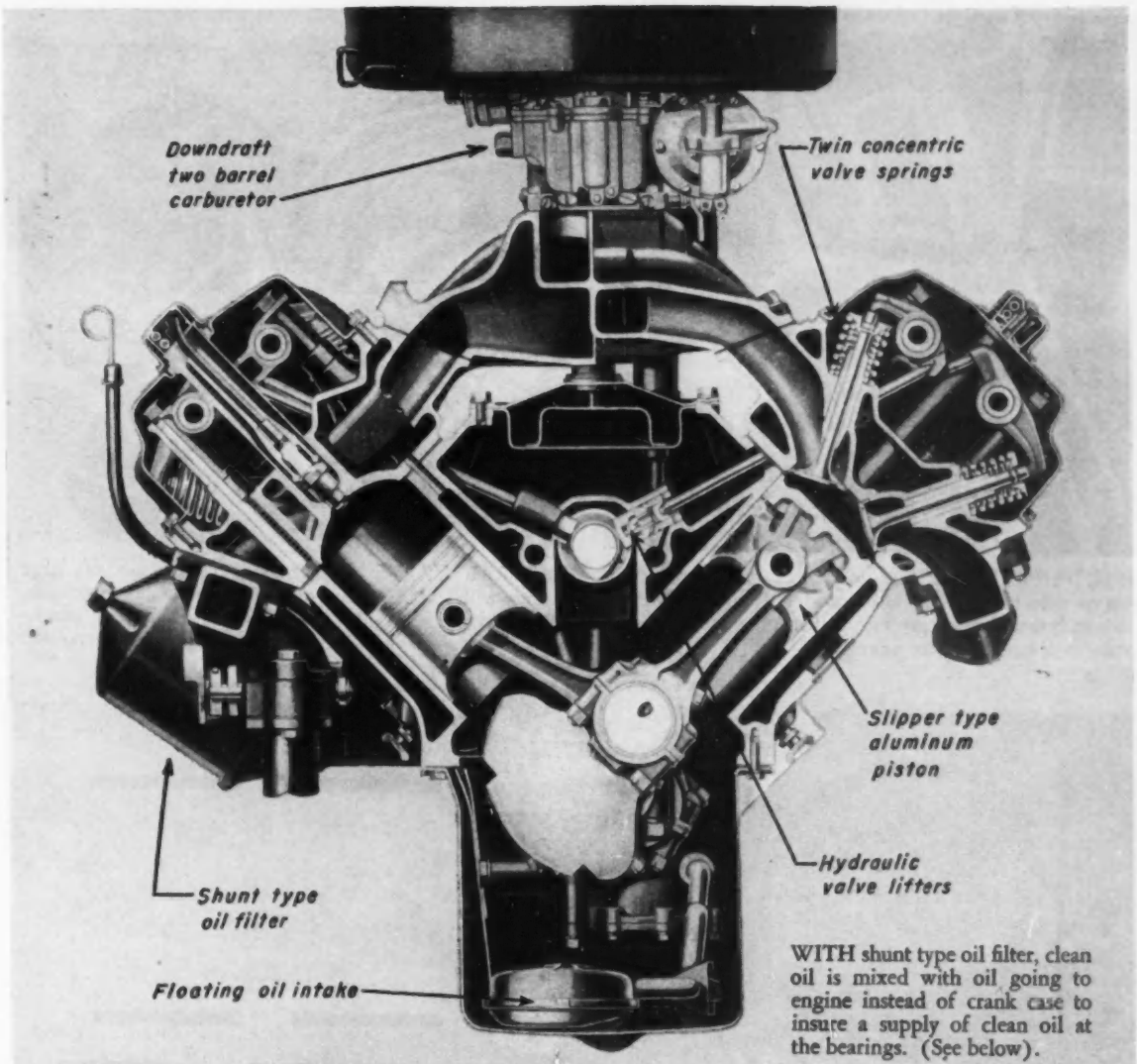
DODGE ENGINE DATA

1953 Red Ram V-8

Max BHP	140
at speed (rpm)	4,400
Max Torque (ft-lbs)	220
at speed (rpm)	2,000 rpm
Compression Ratio	7.1:1
Bore (in)	3-7/16
Stroke (in)	3-1/4
Displacement (cu in)	241.4

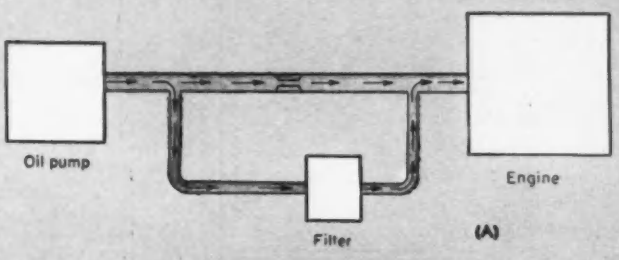
DODGE BODY DIMENSIONS

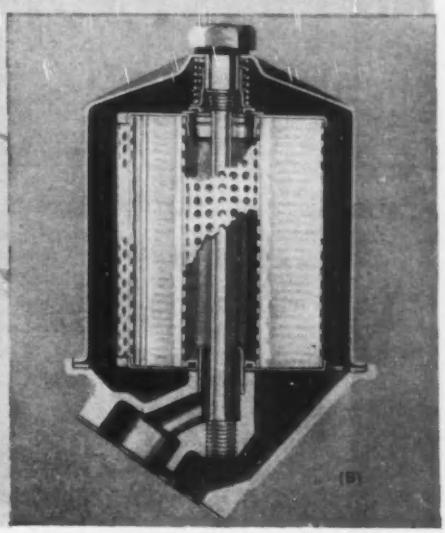
	Four-Door Sedan	*Convertible*
Exterior (in)		
Wheelbase	119	114
Overall length	201-3/8	191-1/4
Overall height	62	61
Overall width	73-1/2	73-1/8

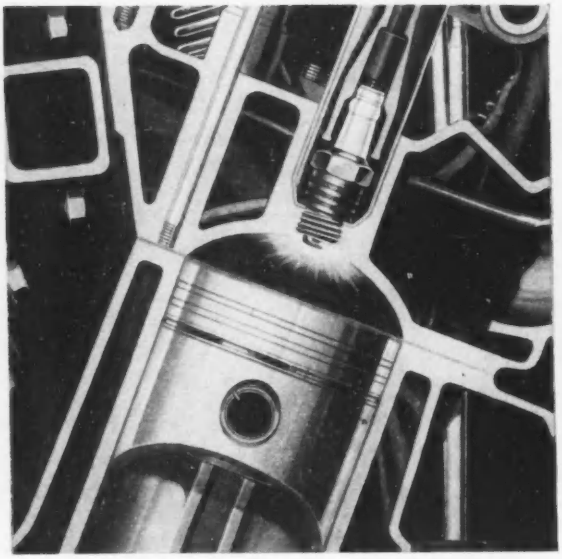


WITH shunt type oil filter, clean oil is mixed with oil going to engine instead of crank case to insure a supply of clean oil at the bearings. (See below).

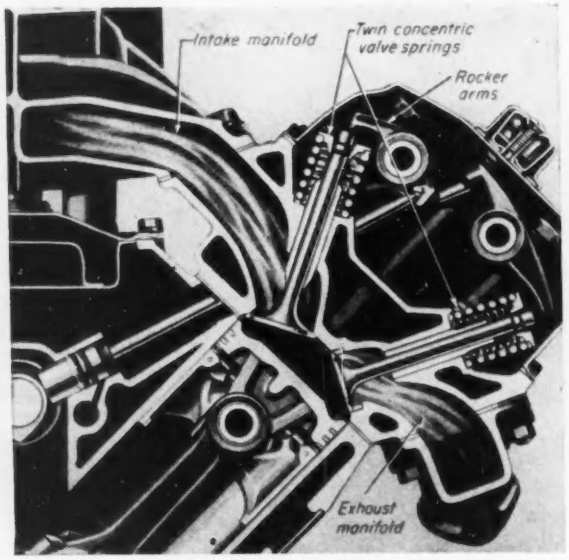
RED RAM ENGINE is eight cylinder overhead-valve V-type engine, with big bore and short stroke. Other features include: Slipper type aluminum pistons with cast-in steel band imbedded in top of skirt for temperature expansion compensation; downdraft, two barrel carburetor uses a thin aluminum throttle body to prevent icing; spark plug is centered in combustion chamber to shorten flame travel; chain-driven camshaft provides quieter operation; and analytical cam design computer-calculated.



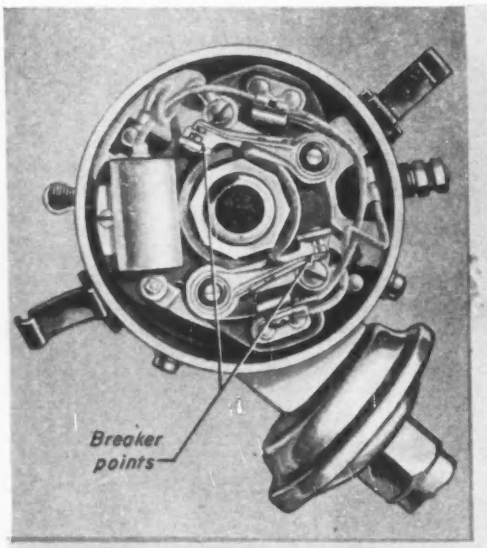


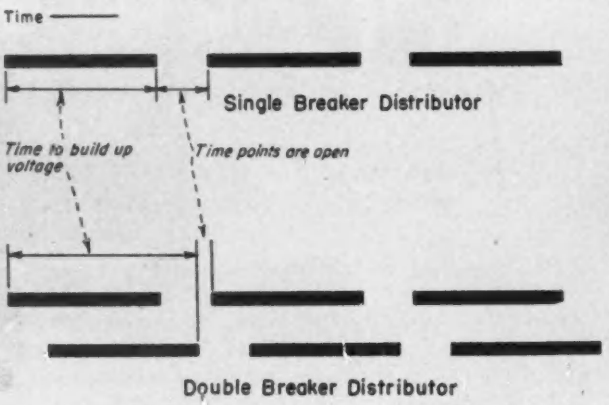


HEMISPHERICAL combustion chamber has low surface-volume ratio to minimize heat transfer. Value design provides turbulence on intake rather than on the compression stroke to obtain complete mixing.

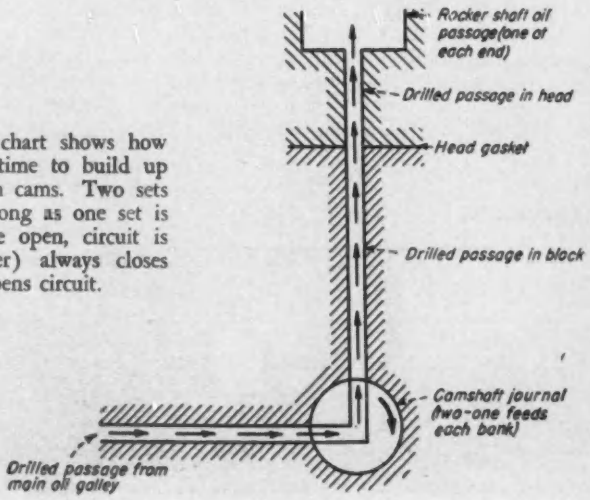


LATERAL VALVE arrangement permits use of large valves with wide spacing between intake and exhaust. Large valve diameter means improved volumetric expansion; wider spacing promotes more efficient valve cooling.





DOUBLE BREAKER DISTRIBUTOR. Time chart shows how double breaker distributor effectively increases time to build up spark voltage without a major design change in cams. Two sets of points are connected in parallel so that as long as one set is closed, voltage can build up. When both are open, circuit is broken. Note that one breaker (make-breaker) always closes circuit while the other (break-breaker) always opens circuit.


Rocker shaft oil passage(one at each end)
Drilled passage in head
Head gasket
Drilled passage in block
Camshaft journal (two-one feeds each bank)
Drilled passage from main oil galley

SCHEMATIC SKETCH of intermittent lubrication system for rocker arms. Lubricant travels from main oil galley through cam shaft journal to rocker arm.

WILLYS: Adds New Models to the Line

When Willys-Overland reentered the standard-sized automobile field last year, circumstances restricted their production to two-door sedans. This year the company will celebrate its fiftieth anniversary by adding three four-door sedans and a hardtop convertible.

Known as the Aero Eagle, the hardtop has been styled with a one-piece wrap-around windshield and rear window, and a sweeping air flow design with rear air fins. Like last year's models, steel body and reinforcing steel members have been welded into one rigid body. The driver can see all four fenders to aid in close parking.

Willys has stepped up their F-head engine by boosting compression ratio to 7.6:1, and horsepower to 90. But they retain the same basic combustion chamber design—compositive L-head and overhead arrangement in which an extra large inlet valve is placed in the cylinder head over the piston and the exhaust valve is in the cylinder block beside the piston; the combustion chamber encircles these valves to provide a more compact construction than conventional L-head chambers.

The company claims that fuel consumption in their new models averages about the same as last year; 27 miles per gallon for conventional transmissions, and up to 35 miles per gallon with overdrive.

Aero Lark

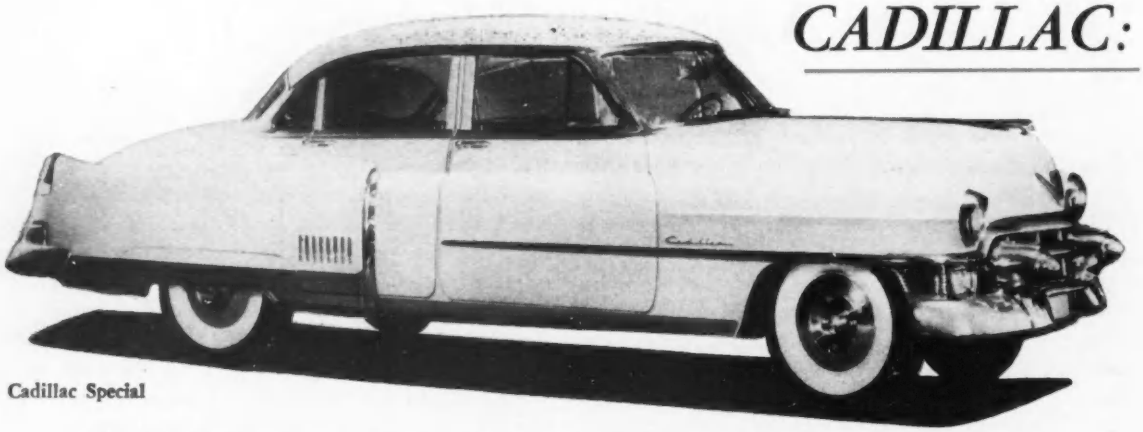
AERO LARK (above) is the lowest priced of the new four-door sedans that Willys has added to their line. Powered by the L-head 75 hp engine, it has extra large doors for easy entrance and exit, and a new chrome beltline.

AERO EAGLE (below) adds a hardtop convertible to the Willys line. Powered by the F-head 90 hp engine, it boasts wrap around windows in front and rear, interiors of a new leather-like fabric and typical Willys aerodynamic styling.

WILLYS SPECIFICATIONS

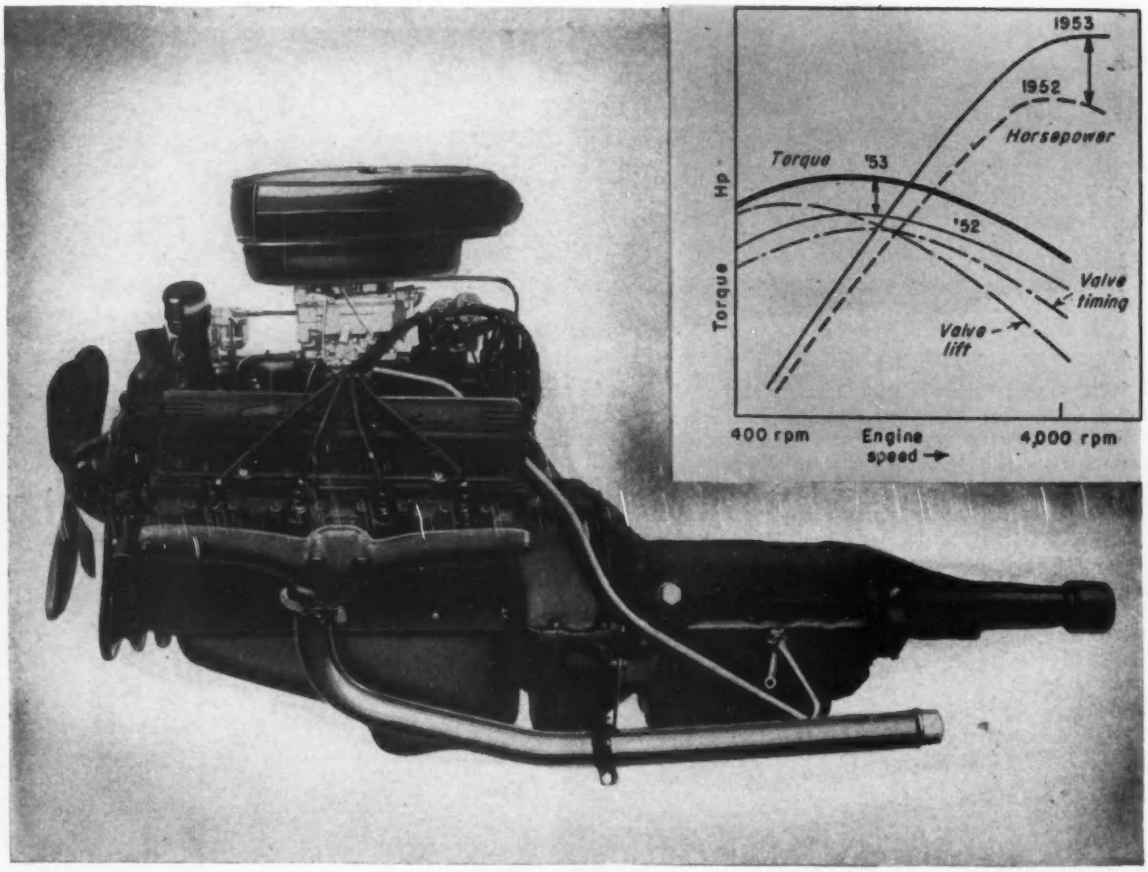
	Hardtop	2-Door and 4-Door Sedan
Overall length	180-7/8 in.	180-7/8 in.
Wheelbase	108 in.	108 in.
Overall width	72 in.	72 in.
Steering ratio	23.7-1	23.7-1
Engine	Hurricane F-Head 6	Lightning L-Head 6
Brake horsepower	90 at 4,200 rpm	75 at 4,000 rpm
Bore	2-1/7 in.	2-1/7 in.
Stroke	3-1/2 in.	3-1/2 in.
Displacement	161 cu. inches	161 cu. inches
Compression ratio	7.6 to 1	6.9 to 1
Torque rating	135 at 1,600 rpm	125 at 2,000 rpm

CADILLAC:



Cadillac Special

WITH AN ENGINE conservatively rated at 210 hp at 4,150 rpm, the new Cadillac has an integral bumper and radiator grille fabricated from low alloy, high strength steel with a welded one-piece bumper rail. Hood line is lower, and other modifications have been made to improve appearance, although principal body dimensions are similar to those in last year's models. Pictured (above) is the 60 Special sedan and (right) the El Dorado special convertible.



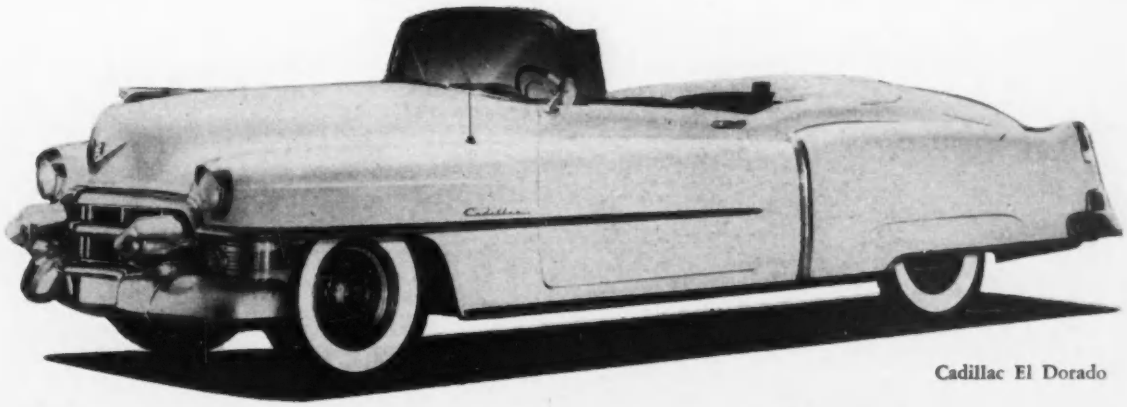
THE V-EIGHT ENGINE features dual exhaust manifolds, a four-barrel carburetor, longer aluminum alloy pistons, and a total displacement of 331 cu. in. Increased valve lift raises the torque rating over the entire operating range. Valve timing changes cause a torque reduction on the low end of the speed curve and increases it on the high end, but the combination of a re-designed combustion chamber and higher compression ratio results in a net gain in both torque and horsepower. Curves are schematic, and compare performance of '53 and '52 engines.

12 Volt Ignition Plus Record Horsepower

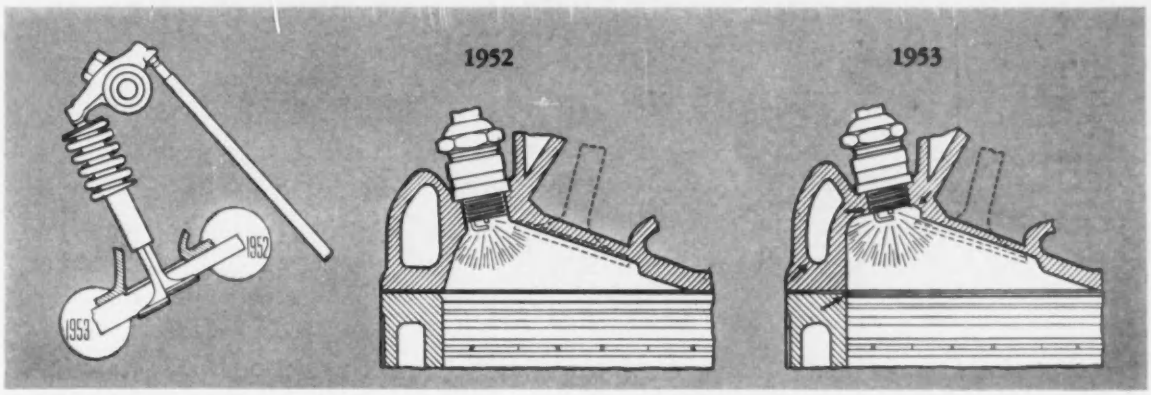
The greater the compression ratio of an automotive engine, the higher must be the voltage at the spark gap to support combustion. Under certain operating conditions such as extreme cold or humid conditions, this requirement may be higher than the peak voltage available with a six voltage distributing system. But with 12 volts —long standard in military vehicles—ignition can be assured at extremely high compression ratios and generator output can be boosted to carry the load from an increasing number of auxiliaries. With these facts in mind, Cadillac engineers, who wanted to increase compression ratio to improve efficiency and economy, as well as smoothness of operation, proceeded by:

- Standardizing on a 12 volt distribution system.
- Increasing compression ratio to 8:25 to 1—and engine torque to 330 ft-lb at 2,700 rpm vs 321 ft-lb in last year's model.
- Lowering the fuel octane requirement by combustion chamber redesign and valve timing modification.
- Increasing valve lift.
- Reducing rear axle ratio to obtain better operating economy.
- Modifying the shift points on the Hydromatic transmission.
- Recalibrating the carburetor for leaner mixtures to take full advantage of spark re-location and to retain rich portions to control all possible areas of detonation.

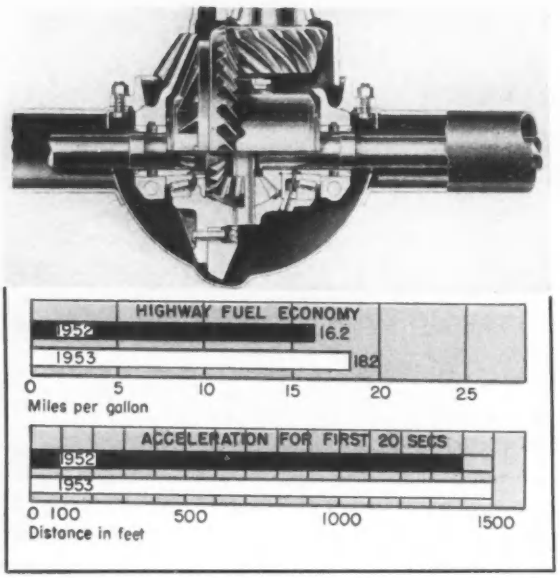
Other changes, also extensive, were made in sheet metal, styling and car heating. Air conditioning is available as optional equipment.



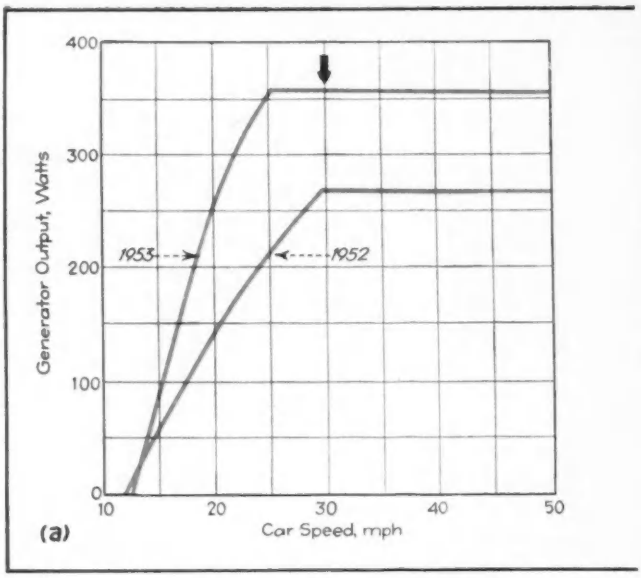
Cadillac El Dorado



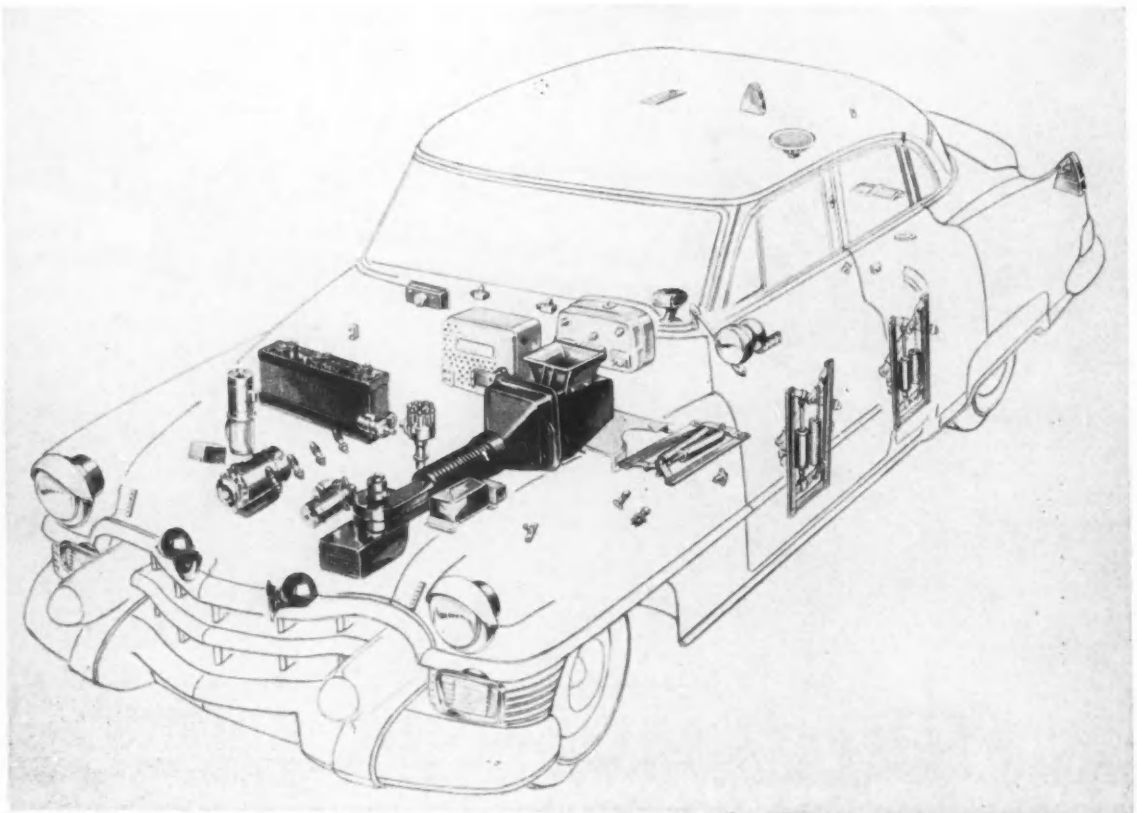
COMBUSTION CHAMBER and valve lift comparisons. Re-design was undertaken to lower mechanically octane rating of the engine. The spark plug has been moved toward the center of the chamber to obtain a shorter flame travel and permit firing on leaner mixtures. A thinner quench area—reduced from about 0.0131 to 0.0040 in.—improves detonation control. The valve lift, increased from 0.327 to 0.360 in., reduces pumping losses. And finally, the camshaft, designed to new standards of maximum rate of change of acceleration, insures smooth performance.



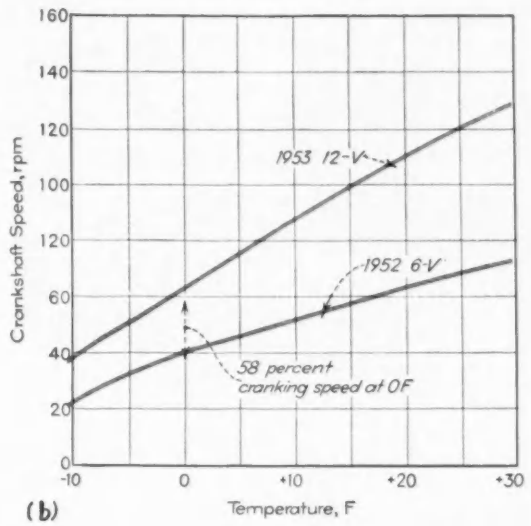
INCREASED POWER of the engine made possible a rear axle ratio of 3.07/1 as compared to 3.36/1 in 1952. Fuel economy is better; a 10 percent lower engine speed reduces wear, friction and pumping loss.

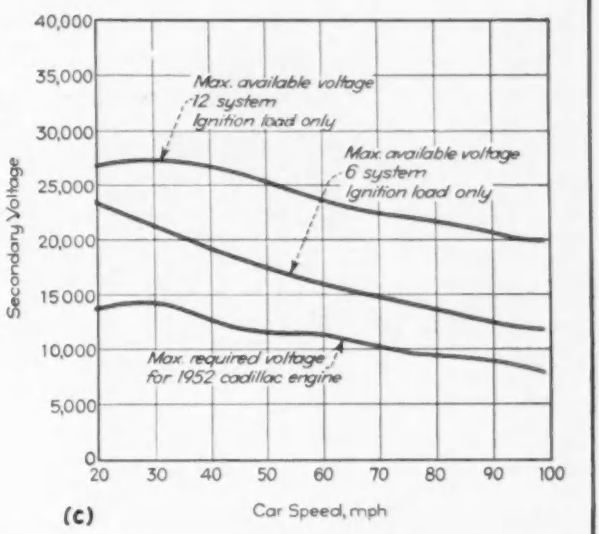


EFFECT OF ELECTRICAL SYSTEM on performance: (A) Generator output is considerably increased even at low speeds, and above 30 mph is 33 percent higher; (B) Cranking speed is up over the operating temperature range

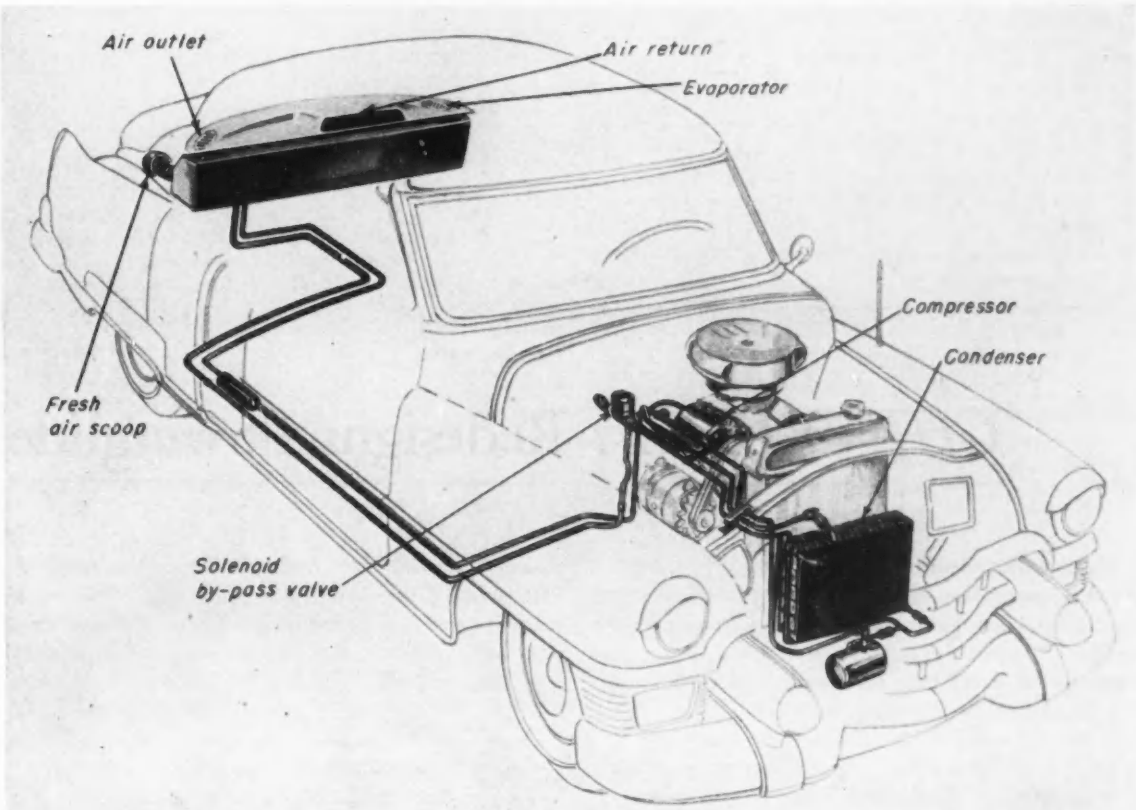


NO SMALL JOB was the switch to 12 v electrical system, as indicated by the accessories affected. All motors are designed for the higher voltage. Solenoids, fuses, circuit breakers, lamp bulbs, radio, spark plugs, and other components carry new specifications. The 11 plate battery gains 46 percent in capacity. And the generator, wound with smaller diameter wire, operates at 2.26 engine speed with a 30 amp 12 v output. Supplier is Delco-Remy.

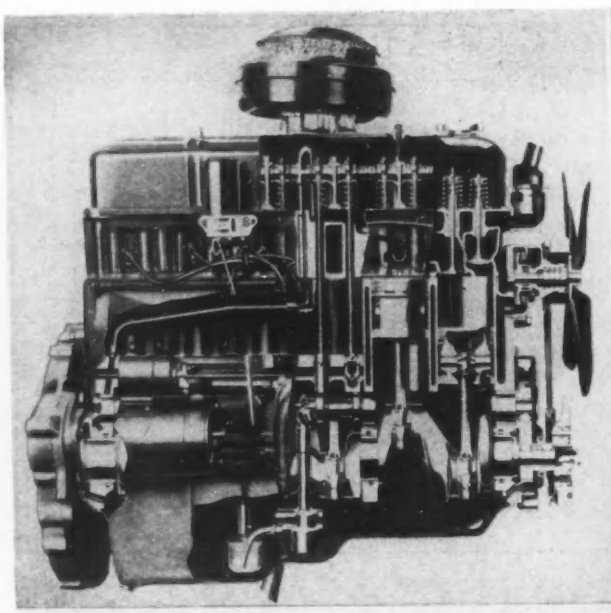


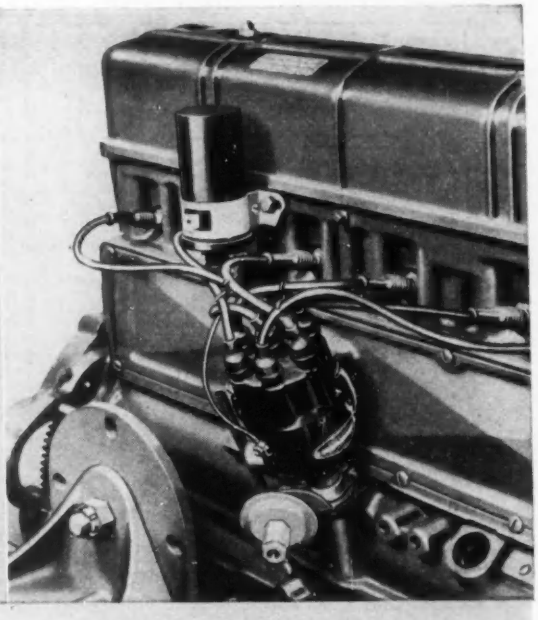


with a higher starting torque motor; and (C) Higher ignition voltages plus a somewhat steeper voltage wavefront aids in alleviating spark plug fouling and improves firing, especially during cold cranking. Tests on a single cylinder engine indicate that a 10 percent increase in breakdown voltage is required for each full ratio change in range of compression ratios from 7:1 to 12:1. These curves were prepared by Delco-Remy who supplied the components.



CADILLAC TYPIFIES the basic approach to air conditioning used in other GM cars. A two stage rotary compressor with a 7.14 cu. in. displacement operates at 1.2 engine speed to boost Freon 12 to 180-190 psi. From there the fluid passes to the condenser, which is mounted ahead of the radiator and then to the evaporator directly under the rear package shelf. Blowers of 300 cfm capacity on each side of the shelf force air through grilles on the shelf.





CHEVROLET CHARACTERISTICS

	Conventional	*Powerglide*
Max. Horsepower	108 at 3,600 rpm	115 at 3,600 rpm
Max. Torque	200 ft-lb at 3,000 rpm	204.1 ft-lb at 2,000 rpm
Compression Ratio	7.1:1	7.5:1
Displacement	235.5 cu in	235.5 cu in
Rear Axle Ratio	3.7:1	3.55:1

Wheelbase	115 in.
Overall length	195.5 in.
Overall width	75 in.

BLUE FLAME ENGINE (left) is based on Chevrolet overall six cylinder design developed in 1933. Output is boosted to 115 hp by increasing compression ratio to 7.5:1. Higher horsepower dictated other changes: new aluminum pistons, sturdier crankshaft, new ignition system and beefed up cooling systems.

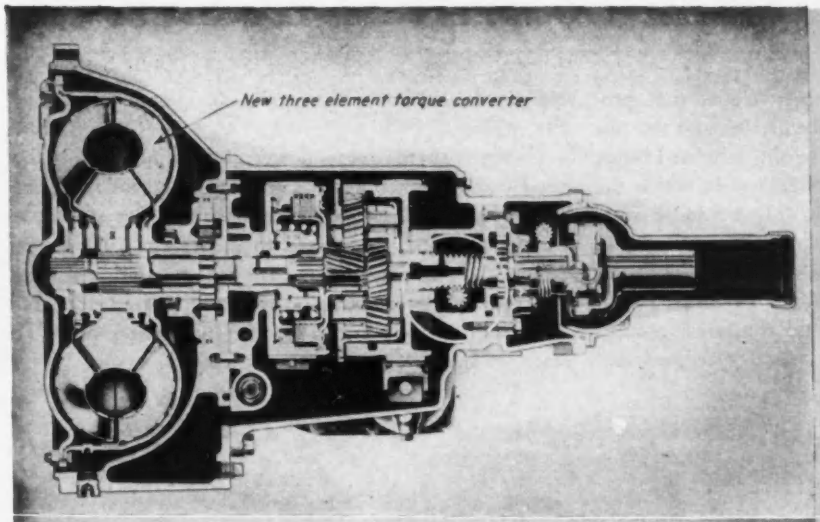
NEOPRENE COMPOUND on spark plugs guards against current leakage and moisture condensation to facilitate wet weather starting. Non-metallic resistance type high voltage cables replace copper leads from distributor to coil and spark plugs. This reduces radio interference.

CHEVROLET: Redesigns Powerglide

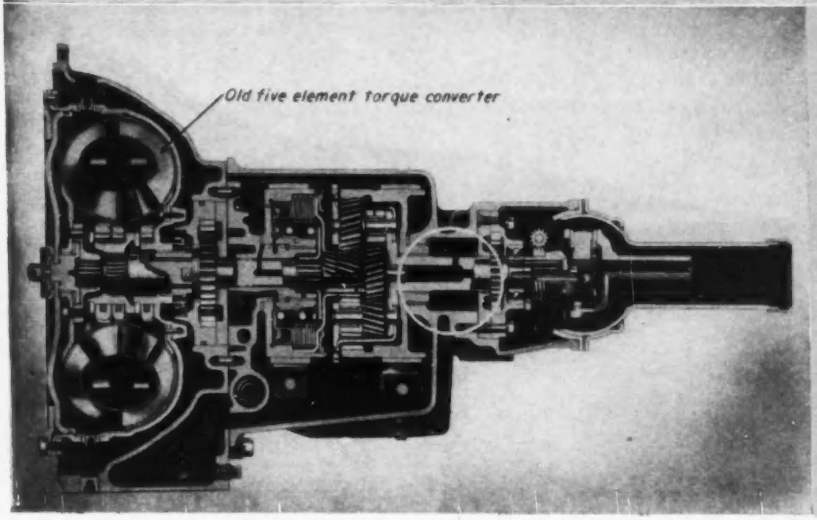
Major design changes expected in the 1953 Chevrolet failed to materialize. But the GM low-priced car underwent several modifications to improve its competitive position. Typical examples: redesigned Powerglide transmission, stepped up horsepower rating of the engines, and new low sweeping styling.

In the Powerglide transmission, the main improvement is the addition of an automatic operation. Starting in the low range, the car now automatically shifts into cruising range. However, the driver can take advantage of the added power of the low-range for passing in traffic, by stepping on the accelerator. Subsequent return to cruising range is also automatic. A manual low is retained to provide extra engine braking when required. Mechanically, they redesigned the torque converter to make it more rugged and more efficient. A larger three element torque converter replaces the previous five-element design; a speed-sensitive governor and load sensitive throttle valve control operation of the new automatic shift; and reduction of the number of elements in the converter simplifies converter design.

The Bel Air Series, a 1953 marketing innovation that includes sedans, sport and convertible coupes, moves Chevrolet out of its traditional price class. With this line, the company becomes the first low-priced car manufacturer to offer the so-called luxury accessories.



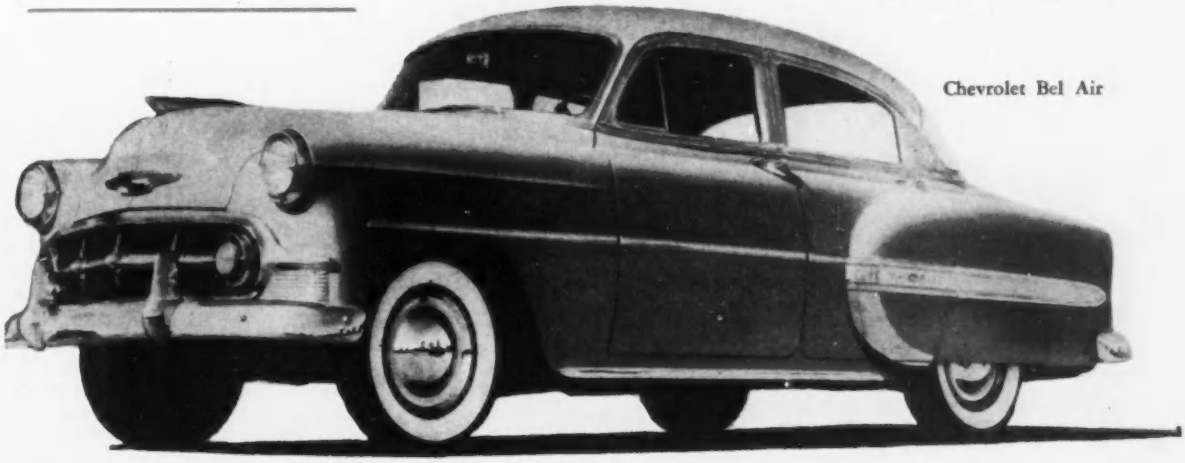
THERE IS a major change in Powerglide transmission. In new unit (left, above) three element torque converter replaces five element converter in previous models (left below). Result: more efficient operation and simplier mechanism. Note addition of speed sensitive mechanism to control new automatic operation.



Bel Air four-door sedan (below) typifies the new line introduced by Chevrolet in 1953. Outstanding styling features include one piece wrap-around windshield, long narrow front and rear fenders, and new grille with three decorative "prop" bars. Optional accessories in this line include power steering and electronic headlight dimmer—in low price field for the first time.

Transmission

IN THE BEL AIR series Chevrolet has concentrated on luxurious interior and exterior appointments.

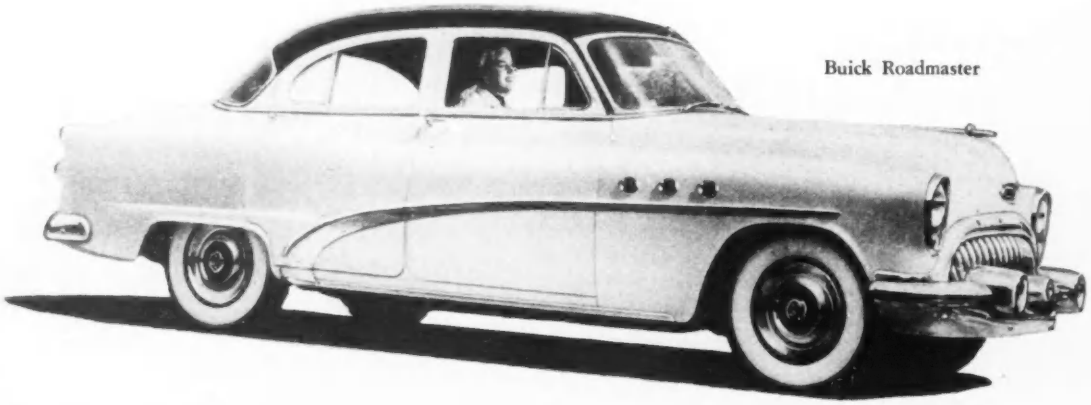


Chevrolet Bel Air

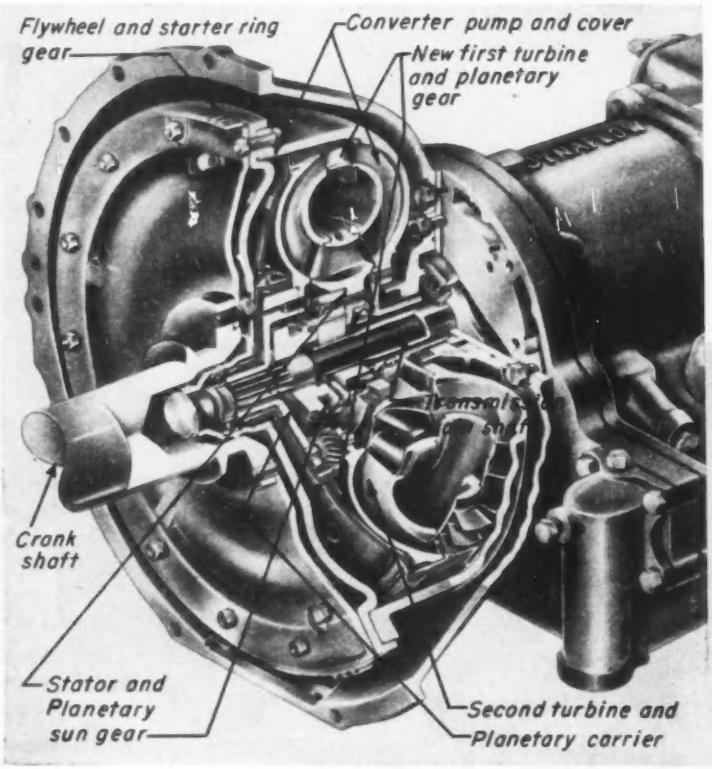
BUICK: V-8 and Redesigned Dynaflow

Cam-contoured crankshaft counterweights that provide uniform clearance between themselves and the piston skirt without lengthening the stroke permitted Buick to develop an overhead valve V-8 engine in which the bore is 4.0 in. while the stroke is only 3.2 in. Result: a compact engine that permits shortening the engine compartment; lower piston speeds and decreased piston travel to reduce wear of piston rings and cylinder walls; and a lower moment of inertia of the crankshaft around its center of rotation to increase critical speeds of torsional vibration past the maximum operating speed of the engine.

Along with the more powerful engine (188 hp for the Roadmaster), Buick has redesigned Dynaflow transmission to boost torque multiplication under stall conditions to 2.45:1, compared to 2.25:1 for 1952 transmissions. The new design also reduces stall speed by 200 rpm. The combination means improved acceleration from a stop, better specific fuel consumption at starting, and fewer converter elements.



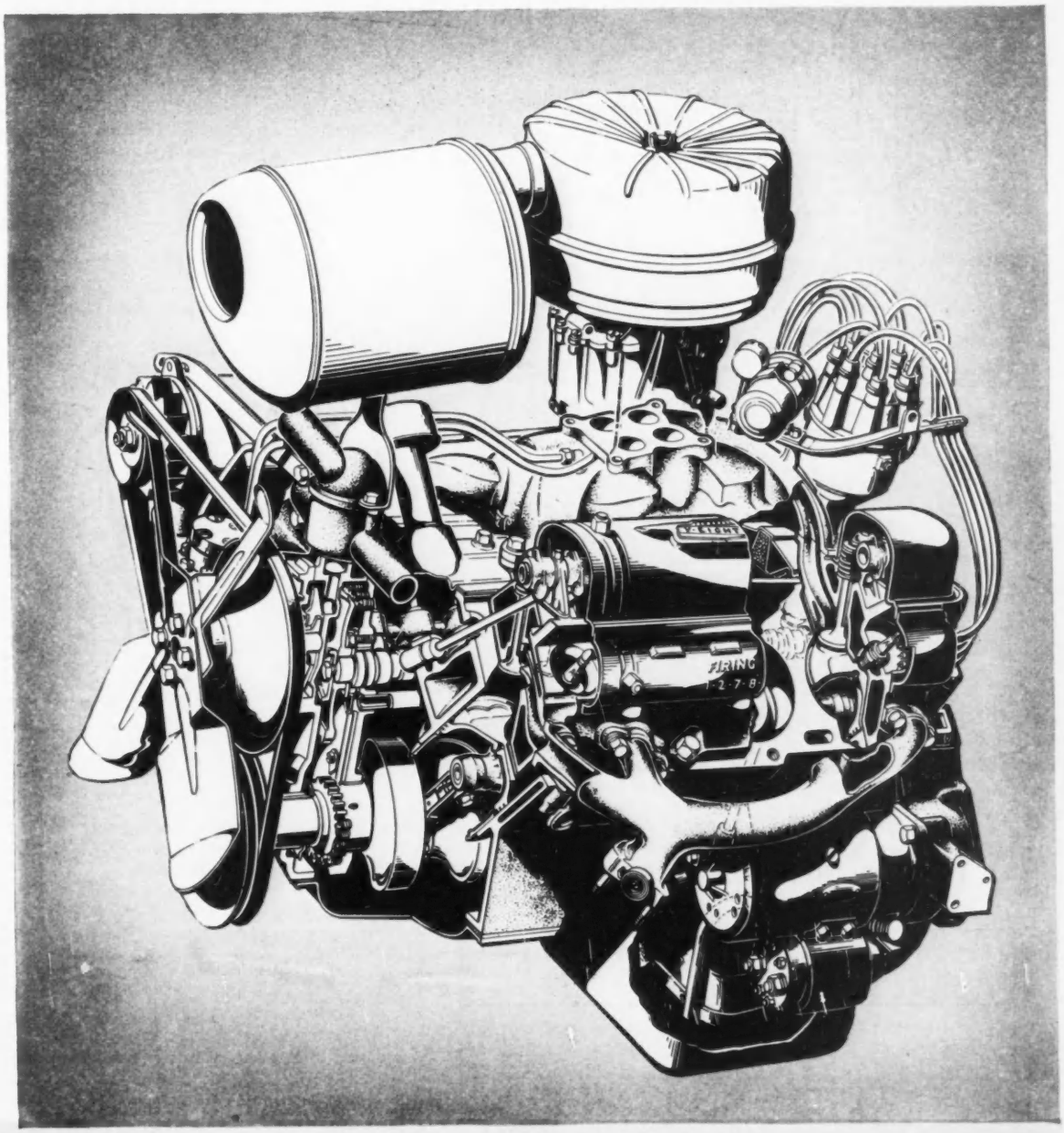
Buick Roadmaster


Flywheel and starter ring gear
Converter pump and cover
New first turbine and planetary gear
Crank shaft
Stator and Planetary sun gear
Second turbine and Planetary carrier

HIGHER and straighter styling of front and rear fenders and hood gives 1953 Buick Roadmaster longer and lower appearance. Wider radiator grille of heavier bars increases amount of air inducted for cooling. Both front and rear windows are one-piece wraparounds to improve visibility.

NEW DYNAFLOW transmission boosts stall torque by adding new first turbine. At high torque application, first turbine does all the driving. Fluid forces on its blades are multiplied by the 1.6:1 planetary gear train before they reach the transmission main shaft. This action produces a torque reaction on the sun gear which is prevented from turning by the over-running clutch.

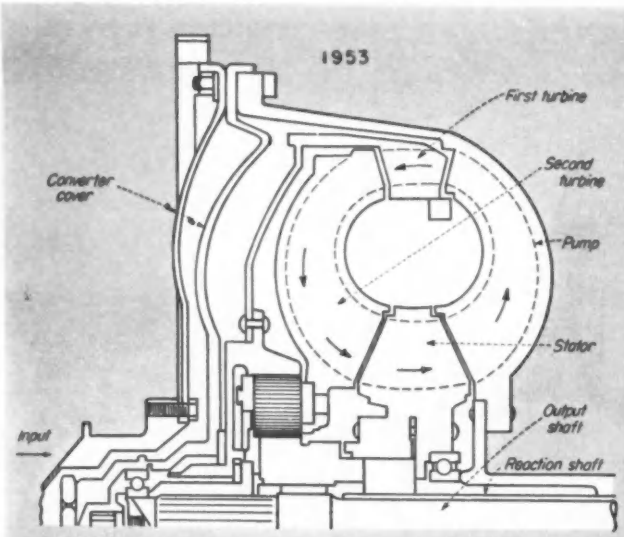
As car speed increases, fluid forces on first turbine decrease and those



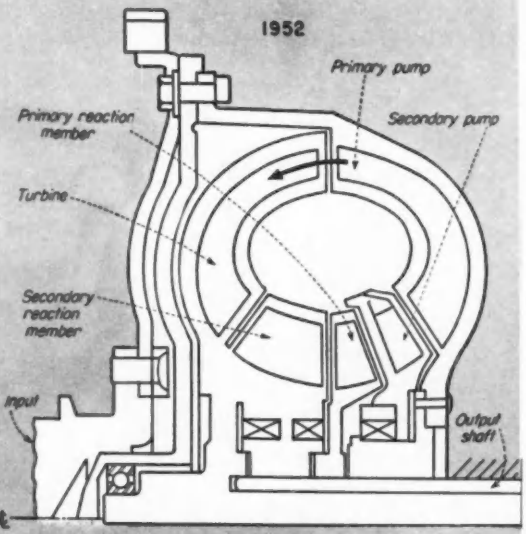
on second turbine increase until the second turbine carries the entire load. When the first turbine is no longer effective, the torque reaction on the sun-gear reverses, causing it to overrun. Direction of fluid flow through the stator shifts so that the stator free wheels when the sun gear free wheels. This arrangement permits the use of only one over-riding clutch instead of three. The unit is further simplified by replacing primary and secondary stators with a single stator.

CROSS-SECTION of new V-8 engine (above) shows new piston head design with flattened dome-shaped top that closely fits cylinder head to raise compression ratio. Shorten camshafts, crankshafts and connecting rods provide more uniform distribution of bearing loads. New exhaust manifold has separate ports for each cylinder to obtain proper scavenging and reduce valve burning. Piston design and valve position increase turbulence.

To overcome ignition difficulties created by the high compression pressures inherent with the 8.5:1 compression ratio, Buick adopted a 12 volt electrical system, similar to that used by Cadillac this year. The car uses one 12 volt battery containing six cells, 11 plates per cell. It is slightly wider than the familiar six volt automotive battery, weighs 53 lb, and has a rating of 70 amp-hr. V-8 design means a weight saving of 170 lb. over the straight-8.



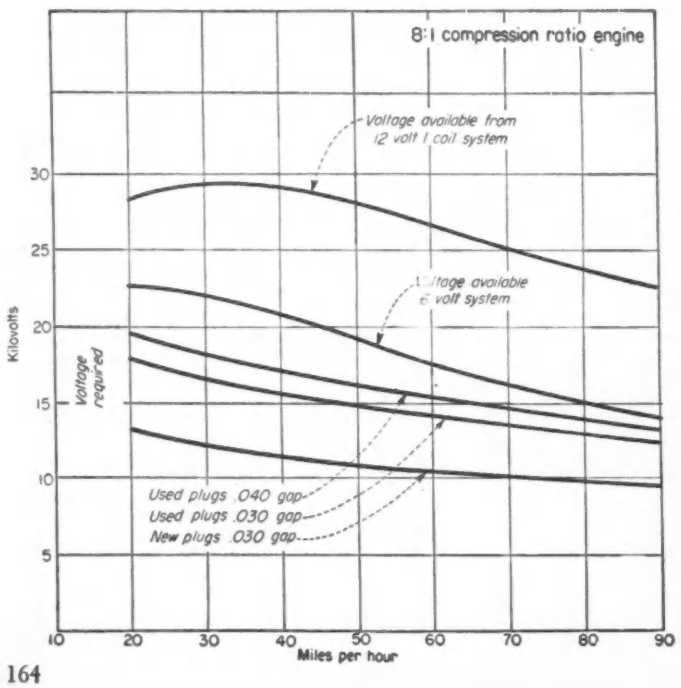
COMPARISON of New Dynaflow (left) with that used in previous models (below) reveals the major changes: new first turbine for starting and high torque applications, single stator instead of primary and secondary stators, and a single converter pump replaces primary and secondary pumps.

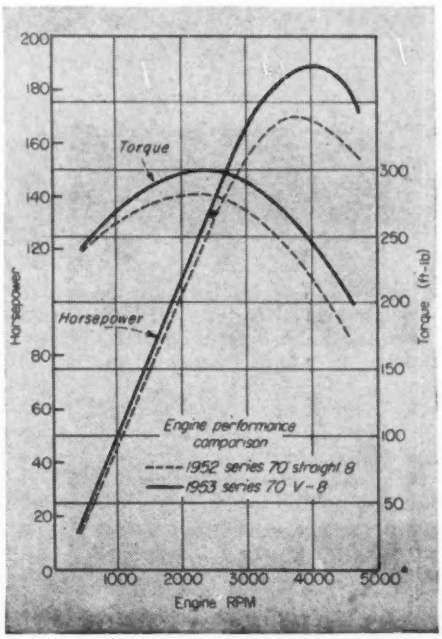


Dynaflow performance comparison
(1953 twin turbine vs 1952 single turbine)

Acceration From 0 to	Reduction in distance Traveled
20 mph	14 ft
30 mph	30 ft
40 mph	50 ft
50 mph	83 ft

VOLTAGE REQUIRED to fire spark plugs under varying conditions as compared to available voltages with a six volt primary system and a twelve volt primary system in an 8 to 1 compression ratio engine. Performance curves (lower right) compare Buick V-8 with '52 straight-8.



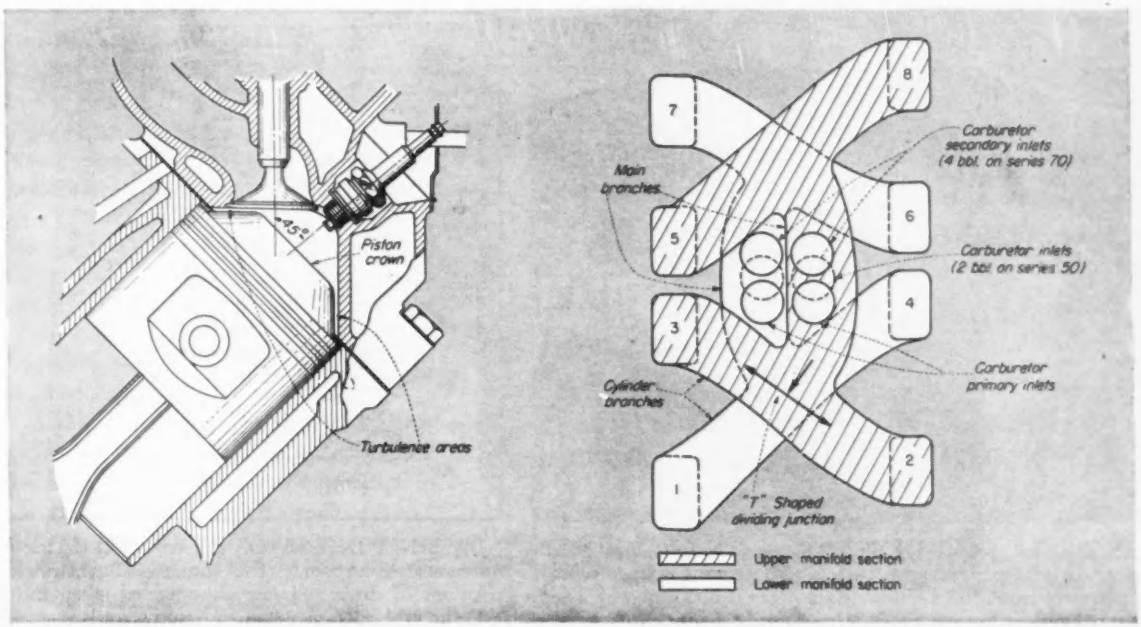


BUICK ENGINE DATA

TYPE	SERIES 40		SERIES 50		SERIES 70	
	1952	1953	1952	1953	1952	1953
	Straight-8	Straight-8	Straight-8	V-8	Straight-8	V-8
Transmission	Dynaflow (opt.)	Dynaflow (opt.)	Dynaflow (opt.)	Dynaflow (opt.)	Dynaflow (std.)	Dynaflow (std.)
Carburetion	Dual	Dual	Two Barrel	Two Barrel	Four Barrel	Four Barrel
Bare Engine Max BHP At speed Crpm	128 3,600	130 3,800	128 3,600	170 4,000	170 3,800	188 4,000
Max Torque (ft-lbs) At speed rpm	225 2,000	230 2,400	225 2,000	292 2,200	280 2,400	300 2,400
Engine W/Standard Access Max BHP At speed Crpm	123 3,600	127 3,800	123 3,600	165 4,000	160 3,800	183 4,000
Compression ratio	7.2:1	7.6:1	7.6:1	8.5:1	7.5:1	8.5:1
Bore (in.)	3.187	3.187	3.187	4.0	3.437	4.0
Stroke (in.)	4.125	4.125	4.125	3.2	4.312	3.2
Engine Displacement (cu. in.)	263.3	263.3	263.3	322	320.2	322
Engine Weight (lbs)	687	687	687	640	815	644

CONE-SHAPED combustion chamber with spark plug centered in the apex reduces width of cylinder head. Central plug location and symmetrical chamber reduce noise and piston slap. Crowned piston with flat top conforms closely to head shape so that area around lower portion of piston causes high turbulence on compression stroke. Because valves are angled at 45 deg, incoming fuel-air mixture is whirled into cylinder for thorough mixing.

INTAKE MIXTURE distribution becomes even more important as engine ratings increase. Poor manifolding can mean serious performance loss and low economy. With their new models Buick used two devices—separate ports for each cylinder and warming the incoming mixture. Sketch below illustrates how Buick brings exhaust gases out to warm the incoming air-fuel mixture for better fuel distribution, more power, better economy.



OLDSMOBILE: Sturdier Design for 1953

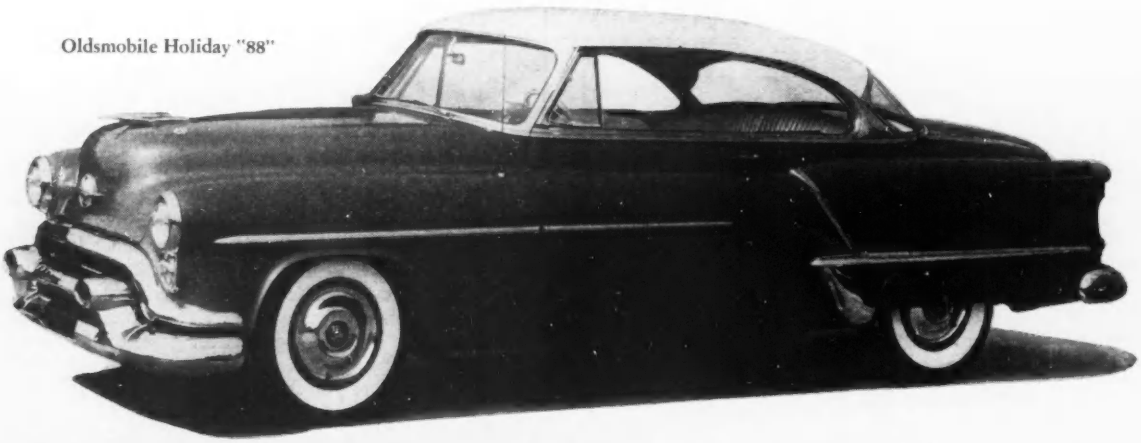
Keeping pace with competition, Oldsmobile boosted compression ratio of their "Rocket" engine in 98 series cars from 7.5:1 to 8.0:1, increasing horsepower rating to 165. And the horsepower increase affected design considerations throughout the car with these results: Larger front wheel bearings, sturdier differential with larger pinion and side bearings, rear bearings spread to distribute load better, stronger rear axle housing, and larger diameter rear axle shaft with 16 splines instead of 10.

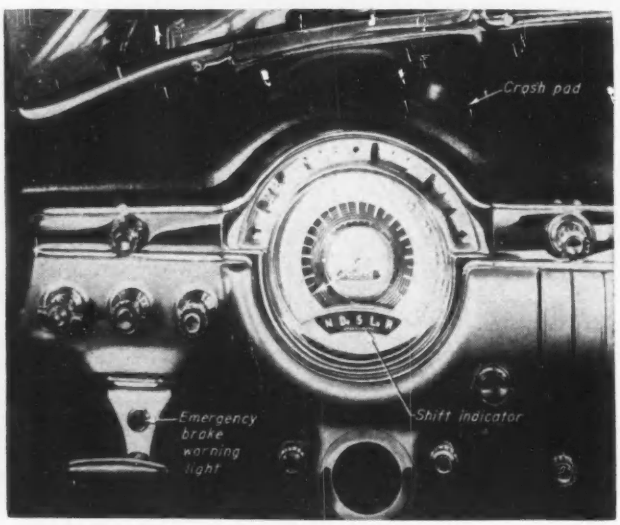
In appearance, all 1953 models boast a new front. Major changes: a square hood line, and elliptical shaped ornaments with decorative louvres replace conventional bumper guards and serve as supports for the upper bumper bar. Rear ends of the 88 series have been restyled to match the angle of the tonneau more closely with that of the rear deck.

On the interior, Oldsmobile made several changes for safety and appearance. Non-reflecting plastic over foam rubber, available as optional extra equipment, provides a safety padded top for the instrument panel. The hydra-matic shift indicator has been moved from the steering column to the new symmetrical instrument panel.

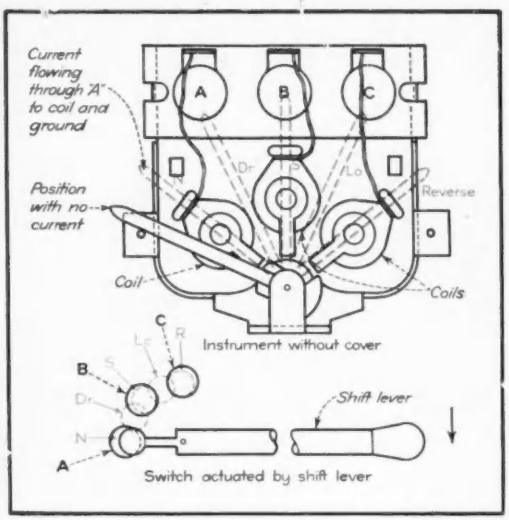
Other major changes include: 12 v electrical system, optional air conditioning, vacuum-hydraulic booster power brakes that reduce braking effort 40 percent, and redesigned power steering, refined for quieter operation.

Oldsmobile Holiday "88"



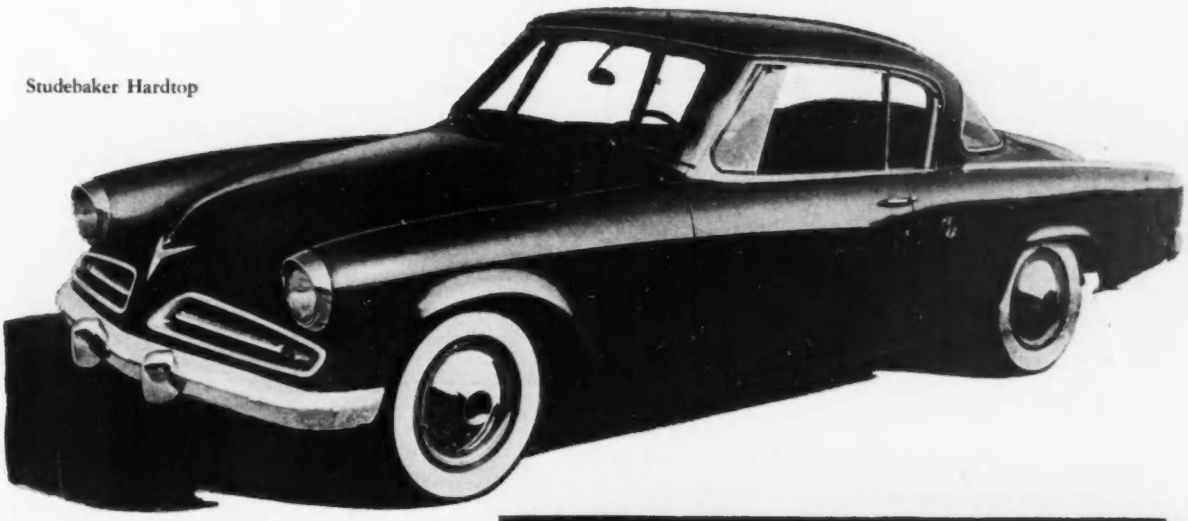


HYDRAULIC SHIFT INDICATOR moves to instrument panel. Note the crashpad, non-reflective plastic covering sponge rubber. Light over hand brake warns driver if car is operated with brake on. Arrows in instrument cluster are directional turn signals.



NEW SHIFT INDICATOR is a three coil electrical instrument that provides five positions. Intermediate positions of drive and low are obtained when shift lever control energizes two consecutive coils.

Studebaker Hardtop



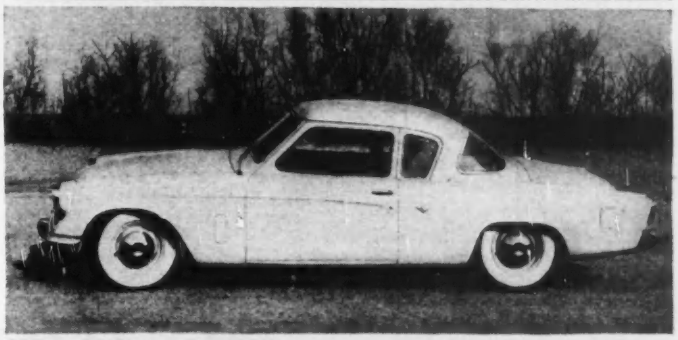
STUDEBAKER:

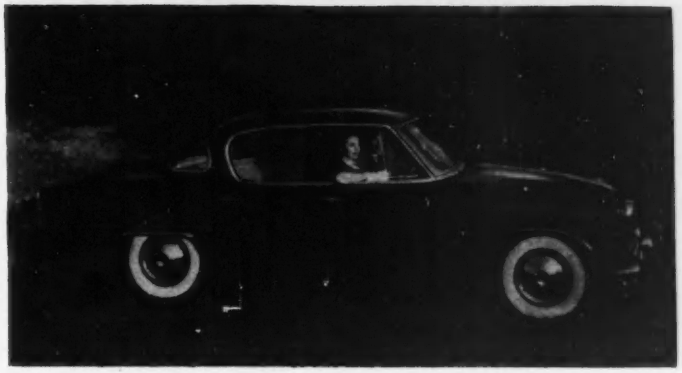
Sport Car Styling For All Models

This year the Studebaker Corporation celebrates its 100th anniversary with a line of models that represent a radical departure from conventional auto styling. Industrial designer Raymond Loewy pulled out all stops to style the raciest standard models in the industry.

Mechanically, Studebaker uses the same basic engine design as last year. They offer, as optional equipment at extra cost, a new type of mechanical power steering. Instead of using hydraulics, this system employs a combination of clutches, planetary gearing and a cam. (Complete details, unavailable at the time this article went to press, will be presented in a subsequent issue of Product Engineering).

A sheave and V-belt drive on the crankshaft transmit power to the clutches which are actuated by a cam moved by rotation of the steering wheel. Less expensive (about $150) than hydraulic power steering, Studebaker's gear takes less power from the engine than hydraulic systems.



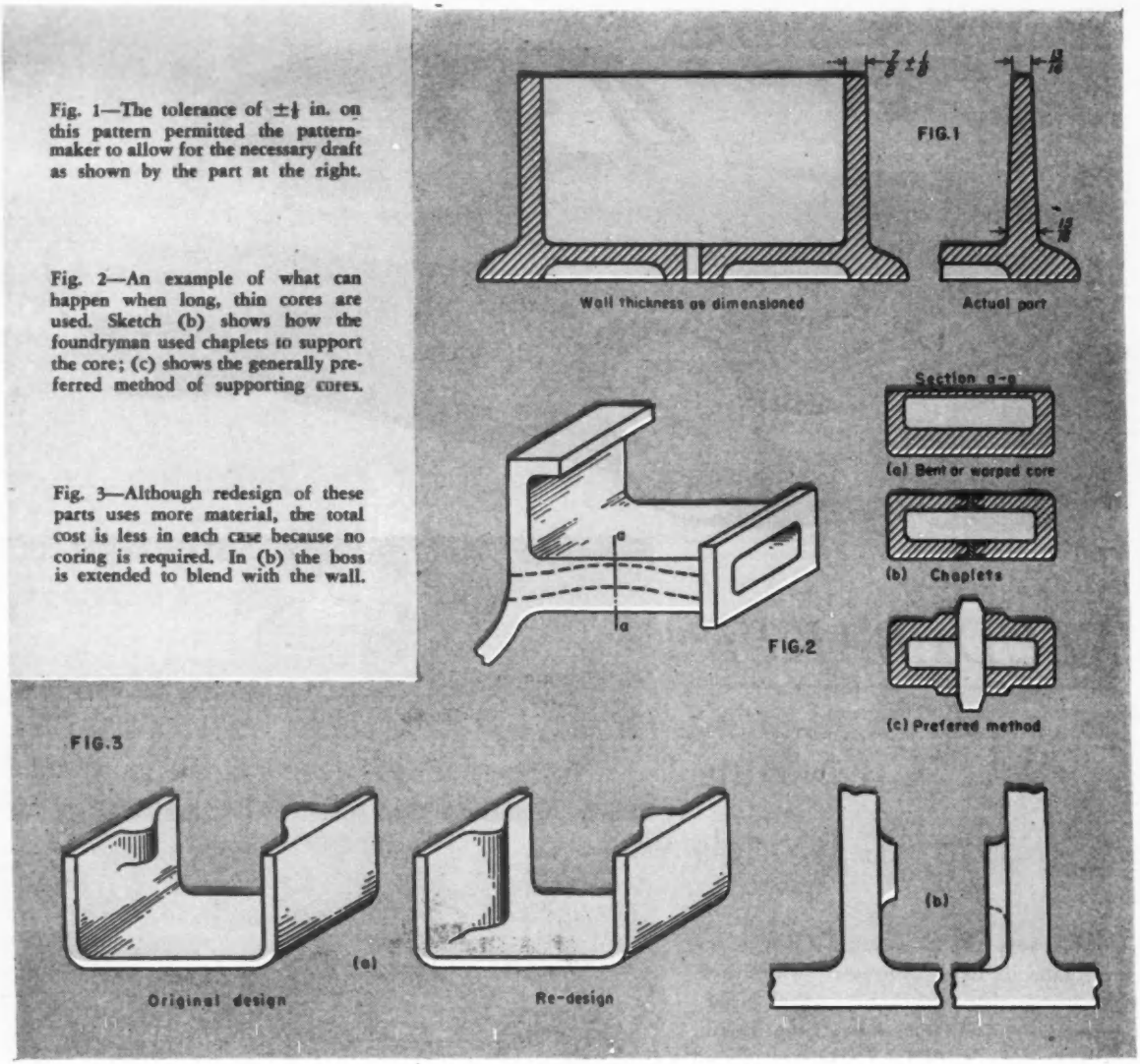


HARDTOP CONVERTIBLE shows off Studebaker's radical continental styling to good advantage. Note exceedingly long, low hoodlines and lines of rear deck are just as low and long. Sport car effect is softened in more conservative four-door family cars.

Fig. 1—The tolerance of ±½ in. on this pattern permitted the pattern-maker to allow for the necessary draft as shown by the part at the right.

Fig. 2—An example of what can happen when long, thin cores are used. Sketch (b) shows how the foundryman used chaplets to support the core; (c) shows the generally preferred method of supporting cores.

Fig. 3—Although redesign of these parts uses more material, the total cost is less in each case because no coring is required. In (b) the boss is extended to blend with the wall.



Designing An Ideal Sand Casting

T. H. TREVITHICK

A review of those factors that make a casting ideal from a production as well as a functional viewpoint. Suggested practices are supported by sketches and tempered with experience. To summarize the author's views: "The designer is not responsible for defects in castings, but rather good design is a requisite to good castings."

FROM PAST EXPERIENCE, it appears that thinking in terms of an ideal casting would help designers solve many foundry problems before they arise. The requirements of this casting would be:

(1) Permit liberal pattern draft.
(2) Minimize surface projections
(3) Solidify progressively
(4) Stress uniform sections
(5) Have liberal fillet radii and minimum re-entrant angles.

As demands for more complicated shapes and higher strength-to-weight ratios increase, the importance of these five factors is magnified, particularly from the aspect of design-foundry co-operation.

All surfaces perpendicular to the

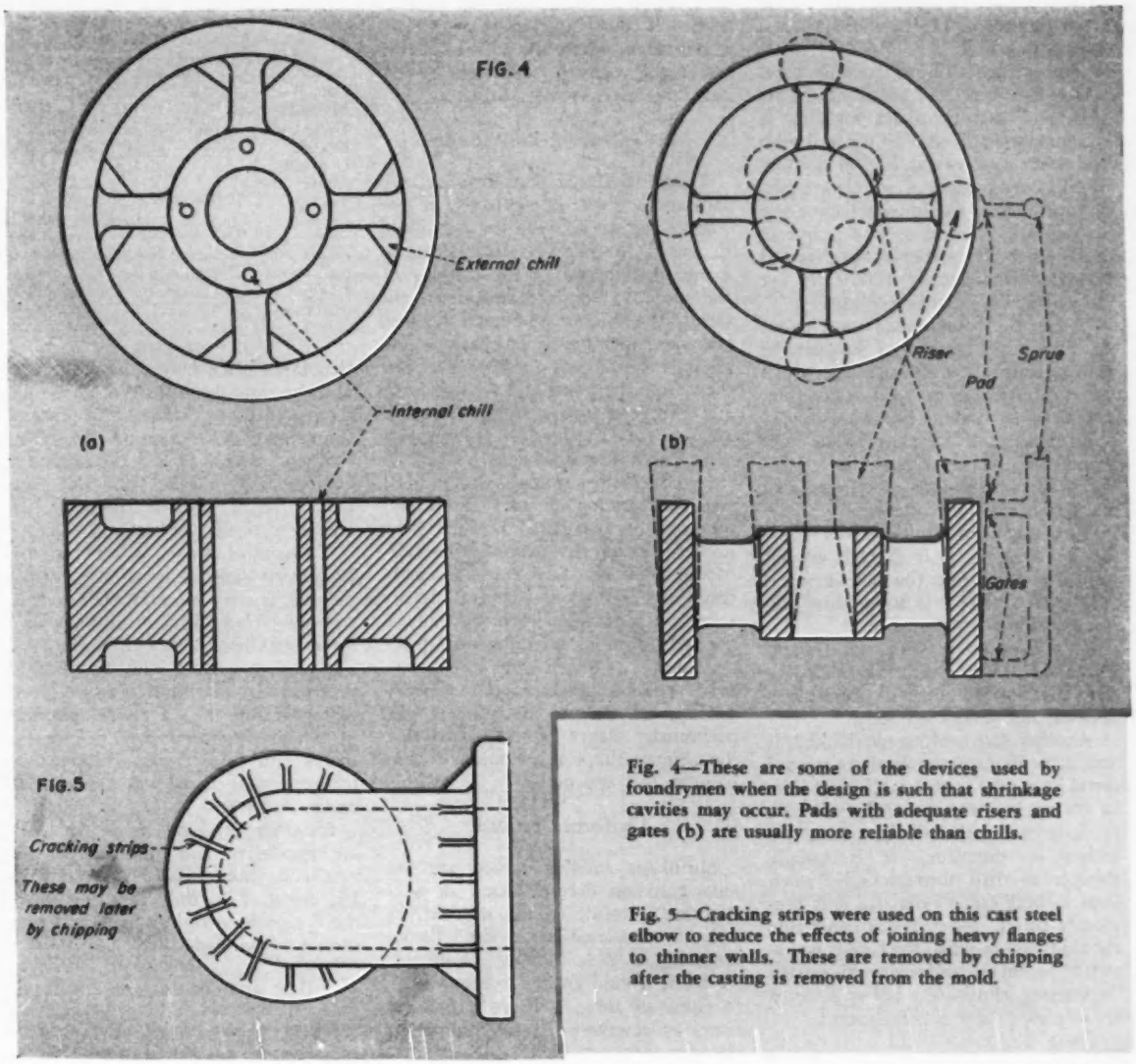


Fig. 4—These are some of the devices used by foundrymen when the design is such that shrinkage cavities may occur. Pads with adequate risers and gates (b) are usually more reliable than chills.

Fig. 5—Cracking strips were used on this cast steel elbow to reduce the effects of joining heavy flanges to thinner walls. These are removed by chipping after the casting is removed from the mold.

parting line of the mold must have enough draft to permit easy withdrawal of the pattern. For general purposes $\frac{1}{8}$ in. per ft, or $\frac{1}{2}$ degree per side is adequate, although drafts larger than one degree are desirable on surfaces that will not be machined and where the slope does not interfere with the function of the part. When mechanized pattern withdrawal is used, such as in large production runs, $\frac{1}{16}$ in. per ft is usually satisfactory. In all cases, however, the need for more liberal allowances on internal as compared to external surfaces should be recognized.

One method of providing a draft allowance that is not taken care of by a general note on the drawing or is not in accordance with such instructions, is shown in Fig. 1. The tolerances of $\pm\frac{1}{8}$ in. on the wall thickness permit the patternmaker to add or subtract material as required, resulting in a section as shown at the extreme right.

Surface Projections

All interior and many exterior features which are not possible to form in the mold with the pattern proper must be formed by coring. Cores in general are costly to produce and add considerably to the molding time required. When they cannot be avoided, costs can be reduced by using green sand cores rather than dry sand types, wherever possible. Two important design factors then must be considered: (1) With green sand cores contours are limited in length to dimensions approximately equal to their diameters; (2) Because they are generally formed in the mold with the pattern, green sand cores require more draft than dry sand, or baked ones, which are made in a separate corebox and often need no draft allowance at all.

With both types, however, size and shape are important. For steel castings, it is good practice to have the core thickness or diameter at least equal to one half the thickness of the wall being cored. For example, a core for a two inch wall should not be less than one inch in diameter or it will become fused with the metal. Dead-end openings should be avoided wherever possible, because they are difficult to support and also because they can present venting problems as a result of gases trapped during pouring. Long thin cores extending into the casting, as illustrated by Fig. 2, are also dangerous. Unless properly supported,

they have a tendency to bend or buckle from the forces of the molten metal during pouring.

The method of supporting cores which minimizes the possibility of rejects and also facilitates molding is that of outlets in the casting wall with coreprints as shown in Fig. 2(c). Obviously, this practice is not always possible; the holes would be objectionable in critically stressed sections. But in many other places, they can be plugged or sealed satisfactorily if they are not desired in the finished product.

When the foundryman must resort to some other method of support, he will probably choose chaplets which are illustrated in Fig. 2(b). Therefore, the designer should be aware of the shortcomings of chaplets so he will avoid them wherever possible.

These shortcomings or dangers can be summarized as follows:

(1) Increased molding costs

(2) Leaks occur if chaplets are not properly fused into the casting metal

(3) If melted too soon, they cannot provide adequate support

(4) Tend to pick up moisture in the mold. During pouring this moisture is vaporized and will cause blowholes if not vented properly.

Another factor often overlooked, is that it is more economical to remove metal by some form of machining than by coring in many cases. This is particularly true with holes less than two inches in diameter. It is usually cheaper to drill through solid stock than to bore out a hole that was previously cored. Exceptions to this rule should be made when the core is necessary to maintain uniformity of section thicknesses, eliminate a hot spot, or to act as a support to a cored recess.

These suggestions for eliminating cores can also be applied to bosses and pads. Like all projecting surfaces, they should either be avoided or blended smoothly into the rest of the surface. The sketches in Fig. 3 illustrate how a saving in total cost may be effected in spite of an increase in the material used. Of course, in cases where weight is critical, or where the added material interferes with the function of the part, this may not be satisfactory.

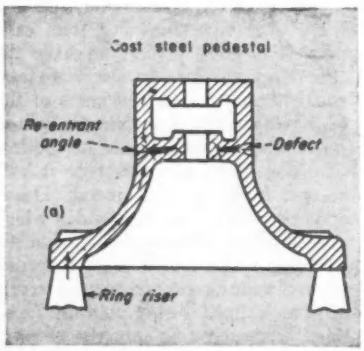


Fig. 6—Example of a re-entrant angle inadequately risered.

Progressive Solidification

During the process of pouring, solidification starts immediately at the contact surface between the metal and the mold. It then proceeds inward at a rate determined by the capacity of the mold to conduct heat from the metal; the thinner and outer sections become solid first. To have sound castings, solidification should start farthest from the gated and feeding areas and progress to the risers. The last areas to solidify should be the uppermost and thickest sections. Thus, an inverted core or wedge is the ideal shape for casting. It satisfies the two requirements just noted as well as the need for progressive solidification. Although few finished parts resemble cones and wedges in outward appearance, the principles involved can be applied to more complex and practical shapes. For example, it is sometimes possible to arrange the heavy sections of the casting, during the preliminary stages of design, so that the ultimate shape as a whole will conform to this approach.

Uniform Sections

Shrinkage cavities, which are the most common defects found in castings are a result of the decrease in volume associated with the change from liquid to solid state. Although it is the foundryman's responsibility to eliminate these voids by providing risers or reservoirs of molten metal, the designer can often alleviate the problem. Obviously, progressive solidification is the ideal solution, but when this is impossible to approach, uniform sections should, at least, be used. Any isolated larger section that cannot be eliminated should be so located that it can be adequately risered.

To help offset shrinkage cavities molders frequently use internal and external chills as shown in Fig. 4(a). However, chills like chaplets, may cause blowholes from moisture pickups in the mold. The safest and most reliable method, therefore, is to use pads with adequate risers and gates as shown in Fig. 4(b). This practice is particularly useful when casting steel, which is subject to greater shrinkage and has a lesser tendency to remain fluid than cast iron. The latter requires comparatively small risers.

Another danger of using abrupt changes in section is that cracks and tears may occur during the contraction that takes place between solidification and the time the casting reaches room temperature. As indicated by Table I, the amount of contraction varies with different metals as well as grades of similar basic metals, thus indicating that a single rule of thumb is not adequate for all applications.

Table I—Typical Contraction Allowances for Castings

Material	Contraction, in. per ft
Cast iron*	1/10 to 1/8
Malleable iron	1/8
Cast steel*	3/16 to 1/4
Brass*	3/16 to 1/4
Copper*	1/4
Aluminum*	3/16 to 5/16
Tin	9/32
Lead	5/16

These are standard allowances, where no restrictions are encountered.
* Differences are caused by various alloying materials.

To control these defects, a thin bracket or strip is sometimes formed on the casting to join the unequal sections. They can be made after the mold is finished by sawing a groove in dry sand or cutting with a trowell in green sand. The high pressure steam elbow in Fig. 5 is a typical example of where they were used. Since the flange had to be much thicker than the pipe wall, there was a danger of cracks and tears.

However, cracking strips like chills are expensive and unpredictable at best and should be considered as a last resort, used only in cases where the design is so rigidly fixed that they cannot be avoided.

Fillets and Re-Entrant Angles

Sharp corners not only produce notch effects, sources of stress concentration, but they also break up the continuity of heat isotherms and interrupt the junction of crystals, which weaken the casting and promote errosion and consequent sand inclusions in the metal. Generous fillets, on the other hand, are a positive approach toward progressive solidification. Closely related to this is the restricted contraction caused by the deep recesses and pockets with re-entrant angles, as illustrated by Fig. 6. These pockets can be a fertile source of cracks and tears.

This particular case involved a medium carbon steel casting (maximum 0.30 percent carbon) having average section thickness of 2 inches. The problem was solved by making it in two parts which were later welded together into one unit. This technique is now being used to fabricate aluminum cylinder heads cast in permanent molds in four sections.

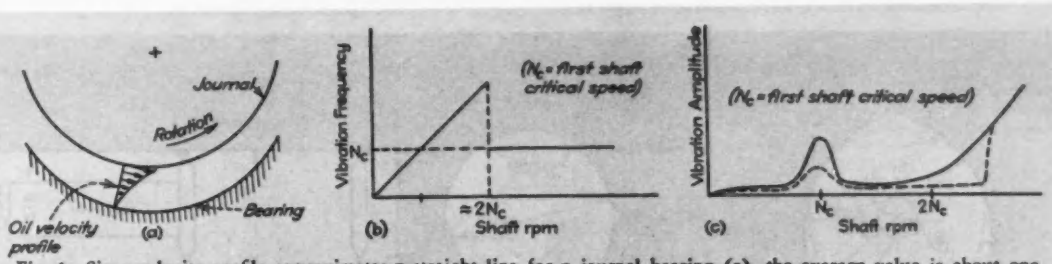


Fig. 1—Since velocity profile approximates a straight line for a journal bearing (a), the average value is about one half the maximum. Thus, when the journal rpm is twice the shaft's first critical speed, the average oil velocity is in resonance with the shaft and oil whip occurs. Curves (b) and (c) show effects on vibration frequency and amplitude.

Fig. 2—Relationship between attitude angle, direction of load application, eccentricity and line of centers for plain journal bearings operating under load.

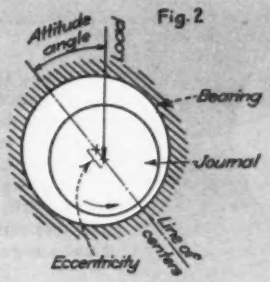


Fig. 2

Fig. 3—Plot of attitude angle versus eccentricity for 150 deg partial bearings with axial inlet oil grooves. These data may be applied to full 360 deg sleeve bearings with good accuracy.

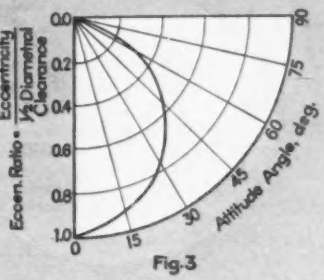
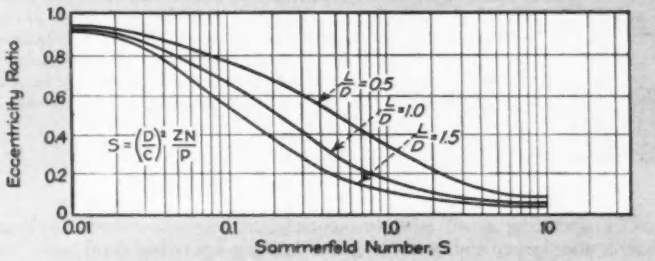


Fig. 3



D = bearing dia, in.
C = diametral clearance, in.
Z = outlet oil viscosity, lb-min/in.²
N = shaft rpm
P = bearing loading = load per bearing, psi / D×L
L = bearing length, in.

Fig. 4—Using Sommerfeld's Number to represent the operating variables, this curve (Ref. 2) gives eccentricity ratio to use with Fig. 3 in determining attitude angles. For stability, the angle should be less than 40 degrees.

OIL WHIP

What It Is and How To Prevent It

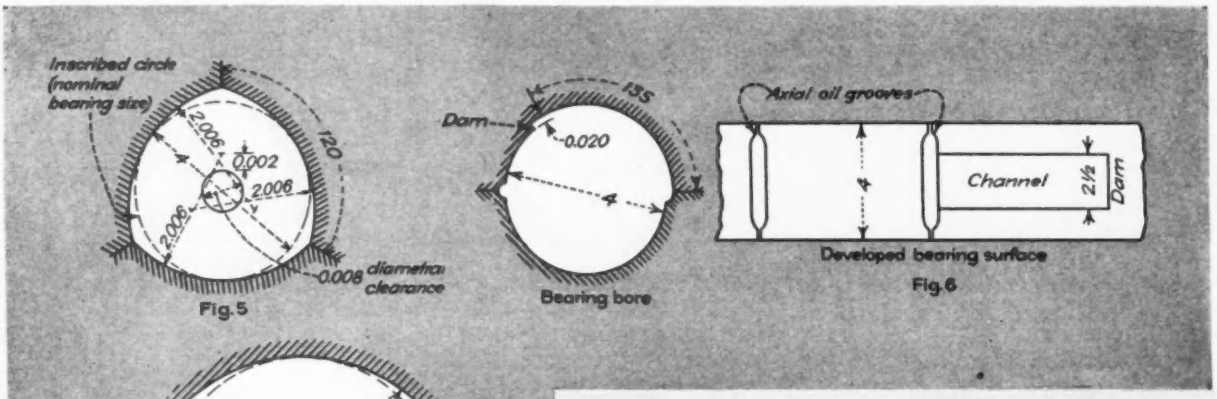
D. P. TIMO
Thomson Laboratory* General Electric Co.

OIL WHIP is a large amplitude shaft vibration whose frequency is equal to the critical frequency of the shaft but which occurs when the shaft is running at some speed other than its critical. It occurs with sleeve bearings above approximately twice the first critical speed of the shaft. Although there is no complete explanation of why it happens, Fig. 1(a) illustrates the theory now generally accepted.

In practice, these vibrations usually begin at 1.8 or 1.9 times the shaft's first critical speed and increase in amplitude as the rpm increases. The operating at light loads and rpm's frequency pattern is illustrated by the idealized plot of Fig. 1(b). This shows that the vibrating frequency is equal to the rpm until whip sets in and then it drops to the critical value and remains nearly constant as the speed is increased further.

An ideal amplitude versus rpm plot it shown in Fig. 1(c). The dotted line illustrates the effect of refining the

*Now with company's Knolls Atomic Power Lab.



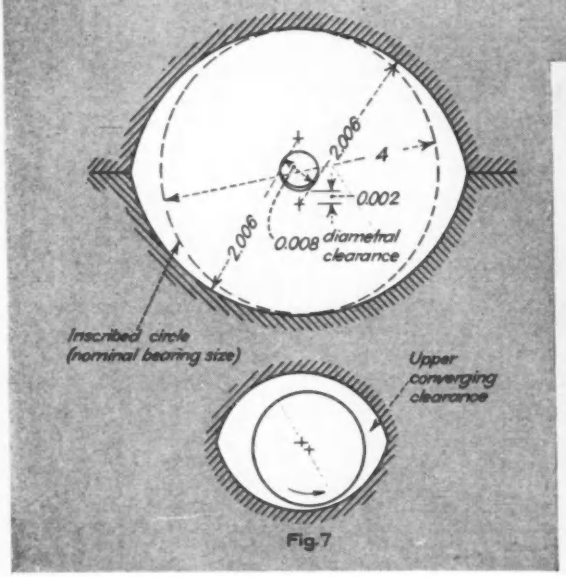


Fig. 5—"Three-lobe bearing" is similar to an elliptical bearing except that it is made up of three arcs, each of whose radii is larger than the radius of the inscribed circle, instead of two arcs. Its method of suppressing oil whip is similar to that of the type in Fig. 7; it provides some self-loading by means of converging oil film spaces in the upper as well as the lower half. The three segments may be of equal size—120 deg or they can be unequal. Two upper segments of 90 deg each and a lower segment of 180 deg have been used successfully.

Fig. 6—"Pressure bearing," which has proven satisfactory in some cases, has a cylindrical bore with a channel in the upper half of the bearing terminating in a dam. A sketch of the bearing bore and typical dimensions are shown. This bearing is intended for unidirectional rotation only. A pressure is built up at the dam by a conversion from oil velocity head to pressure head; thus, a downward pressure on the journal is

shaft balance; the amplitude is reduced and whipping is delayed to a speed in excess of twice the shaft critical. Then a random stimulus excites it, and the amplitude jumps to the value it would have had with an unmodified shaft.

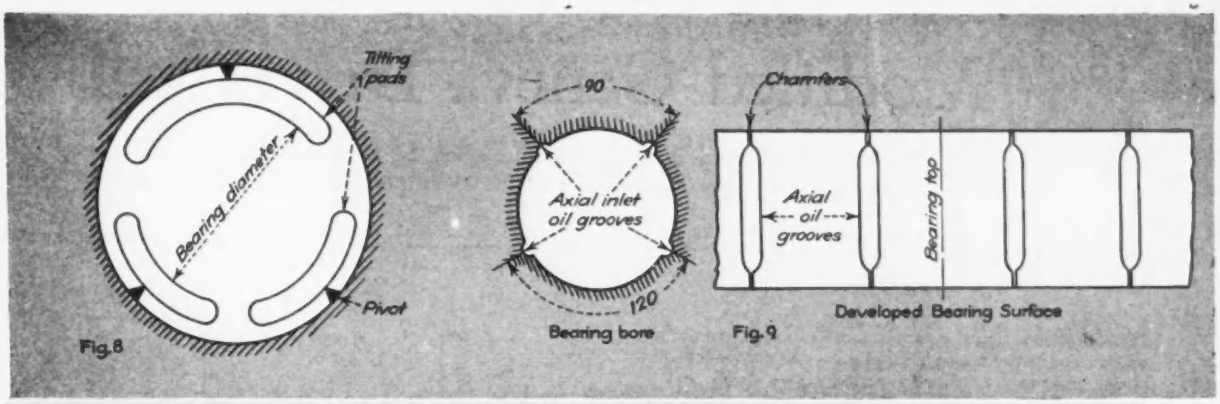
The fact that whip does not occur unless the bearing load is light indicates that this instability is a function of the journal position since changing the loading causes the journal to move relative to the bearing. As shown in Fig. 2, the position of the journal is defined jointly by the attitude angle and the eccentricity which themselves are related.

For sleeve bearings, there is one value of eccentricity for every value of attitude angle. The relationship which determines this value has been deduced analytically and substantiated experimentally. It is plotted in Fig. 3. This curve is the locus of the journal center as the loading is varied. An increase in load causes the journal to move lower in the bearing; that is, at a smaller attitude angle and larger eccentricity. Therefore, instability can be caused by operating at an attitude angle that is too large, and a corresponding eccentricity that is too small. This seems reasonable since oil whip is, in effect, a continuous rotation of the line of centers or a continuously increasing attitude angle in the direction of shaft rotation at a specified angular velocity. At operating conditions calling for large attitude angles, the line of centers is more nearly horizontal making it easier for the line of centers to flip over and continue rotating.

Empirical data have shown that for attitude angles smaller than approximately 40 deg, the bearing is stable and whip does not occur. Hence, a correlation between attitude angle and the bearing operating conditions, such as Fig. 4, will help design whip out of an installation. By substituting the bearing operating variables into the expression for the Sommerfeld Number a value of eccentricity ratio can be determined; the attitude angle corresponding to this eccentricity ratio can be obtained from Fig. 3. Obviously, any change in the variables which comprise the Sommerfeld Number will effect a change in journal position and hence its stability. Therefore, these variables should be chosen such that the attitude angle is less than 40 degrees, at journal rpm values above twice the shaft's critical speed.

Preventing Or Eliminating Oil Whip

It was stated previously that two conditions are necessary for whipping to occur. These are (1) that a rotating member supported in sleeve bearings be running at an angular velocity in excess of twice its critical speed, and (2) that the bearing be lightly loaded. By light loading is meant that the effective loading of the bearing is such that the attitude angle is greater than approximately 40 degrees. Thus, the simplest and most direct way of preventing whip is to have the operating speed less than 1.5 times the critical



created to provide a measure of self loading. One disadvantage besides its unidirectional characteristic, is the tendency for dirt and impurities present in the oil to accumulate at the dam and thus cause scoring of the journal.

Fig. 7—This design has a non-cylindrical bore made by machining the bearing cylindrical with shims between the two halves. After machining the shims are removed. The departure from a circular cross-section is small as shown. Its anti-whip characteristic results from the fact that a converging oil film space is provided in the upper bearing half as well as in the lower section. This slightly converging space causes a measure of self-loading, tending to stabilize the journal, by creating a pressure in the same manner as the load-carrying pressure is produced hydro-dynamically in the lower half. To insure this convergence, the radii of the two halves extend beyond the clearance circle by a few mils.

Fig. 8—"Tilting pad" or "pivoted shoe" type is the most dependable of the anti-whip bearings mentioned. It is usually made up of three or four segmental shoes, each pivoted at its mid point, so that the bearing configuration can change in accordance with the shaft equilibrium position. In all cases where it has been used it has proven successful in preventing or suppressing oil whip. Its chief disadvantage is that it is by far the most expensive to manufacture of any of the types shown. In spite of this, its use is justified in many cases.

Fig. 9—"Axial groove bearing" has a cylindrical bore with three or more axial inlet oil grooves. A typical four-axial groove bearing is shown. The reason for its anti-whip characteristic is not at present understood. It has been shown from experience, however, that an axial groove bearing having more than the usual two inlet oil grooves acts to suppress oil whip. Numerous installations support this observation.

shaft speed. Then whipping cannot occur. If the installation is such that the speed must be in this critical range, the next best insurance is to have a sufficiently high bearing loading.

The most obvious way to increase loading is to decrease the projected area by shortening the bearing length. This again is not always feasible, since some bearings must operate satisfactorily at high emergency outputs as well as at light normal conditions. Thus, if the bearing operating characteristics are so fixed that both of the conditions necessary for oil whip are present, anti-whip bearings such as those in Figs. 5 through 9 may be the only solution. The most effective of these is shown in Fig. 8; the second most dependable is the three-lobe design, Fig. 5. The latter has been successful in suppressing oil whip in many cases where it occurred with plain cylindrical bearings. The axial-groove bearing, Fig. 9, has also been successful to a large extent; the pressure bearing and the elliptical bearing to a lesser extent.

All of these special designs, however, require that a premium be paid for their ability to suppress the instability. Each of the bearings shown requires higher oil flow, produces a greater power loss, and is more expensive than an ordinary sleeve bearing. Another common disadvantage is that no complete analysis has been made of these types, such as exists for plain bearings, so that their performance cannot be reliably predicted except as indicated by actual test data.

Summary

The foregoing discussion deals mainly with prevention of oil whip in new designs. For machines already in use, the first step is to recognize whip when it is present. Most cases of this type are characterized by a troublesome vibration which cannot be eliminated or suppressed by a refinement of balance. The first thing to check then is whether or not the speed is in the critical range. If the shaft's critical speed is not known, it can be determined experimentally by plotting a curve of vibration amplitude versus speed; a peak in vibration amplitude will occur at this point. The vibration frequency can be measured with a Frahm vibration indicator. If the frequency of the vibration is close to twice the critical speed of the shaft and the vibration frequency remains relatively constant at this frequency as the shaft speed is varied in the oil whip speed range, the instability is being caused by oil whip. Its prevention or elimination then can be attacked by any of the methods that were outlined previously.

REFERENCES

1. B. L. Newkirk, "Shaft Whipping," *General Electric Review*, March 1924, page 169.

2. M. Rosenblatt and D. F. Wilcock, "Oil Flow, Key Factor in Sleeve Bearing Performance," *ASME Trans.* Vol. 74, July 1952, page 849.

3. H. Poritsky, an unpublished paper.

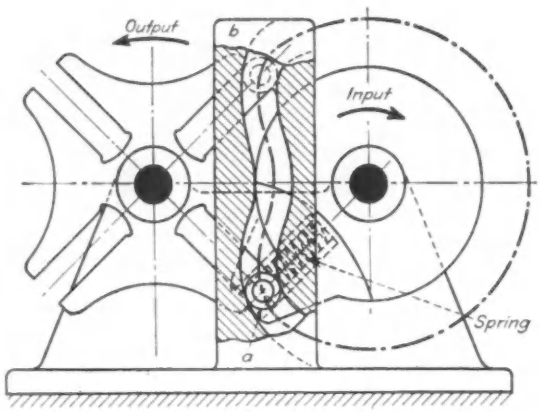
4. D. Robertson, "The Whirling of a Journal in a Sleeve Bearing," *Phil. Magazine*, Vol. 15, page 113 (1933).

5. M. C. Shaw and E. F. Macks, "Analysis and Lubrication of Bearings," McGraw-Hill Book Co., 1st Edition, 1949, page 357.

Modified Geneva Drives and

These sketches were selected as practical examples of uncommon, but often useful mechanisms. Most of them serve to add a varying velocity component to the conventional Geneva motion. The data

Fig. 1—(Below) In the conventional external Geneva drive, a constant-velocity input produces an output consisting of a varying velocity period plus a dwell. In this modified Geneva, the motion period has a constant-velocity interval which can be varied within limits. When spring-loaded driving roller *a* enters the fixed cam *b*, the output-shaft velocity is zero. As the roller travels along the cam path, the output velocity rises to some constant value, which is less than the maximum output of an unmodified Geneva with the same number of slots; the duration of constant-velocity output is arbitrary within limits. When the roller leaves the cam, the output velocity is zero; then the output shaft dwells until the roller re-enters the cam. The spring produces a variable radial distance of the driving roller from the input shaft which accounts for the described motions. The locus of the roller's path during the constant-velocity output is based on the velocity-ratio desired.



Saxonian Carton Machine Co., Dresden, Germany

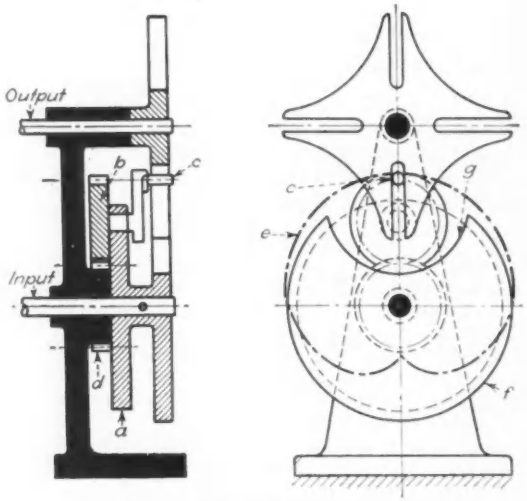


Fig. 2—(Above) This design incorporates a planet gear in the drive mechanism. The motion period of the output shaft is decreased and the maximum angular velocity is increased over that of an unmodified Geneva with the same number of slots. Crank wheel *a* drives the unit composed of plant gear *b* and driving roller *c*. The axis of the driving roller coincides with a point on the pitch circle of the planet gear; since the planet gear rolls around the fixed sun gear *d*, the axis of roller *c* describes a cardioid *e*. To prevent the roller from interfering with the locking disk *f*, the clearance arc *g* must be larger than required for unmodified Genevas.

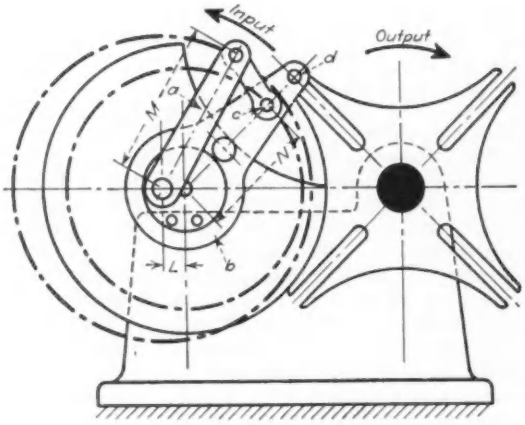


Fig. 3—A motion curve similar to that of Fig. 2 can be derived by driving a Geneva wheel by means of a two-crank linkage. Input crank *a* drives crank *b* through link *c*. The variable angular velocity of driving roller *d*, mounted on *b*, depends on the center distance *L*, and on the radii *M* and *N* of the crank arms. This velocity is about equivalent to what would be produced if the input shaft were driven by elliptical gears.

Special Mechanisms

SIGMUND RAPPAPORT
Ford Instrument Company

were based in part on material and figures in AWF und VDMA Getriebeblaetter, published by Ausschuss fuer Getriebe beim Ausschuss fuer wirtschaftiche Fertigung, Leipzig, Germany.

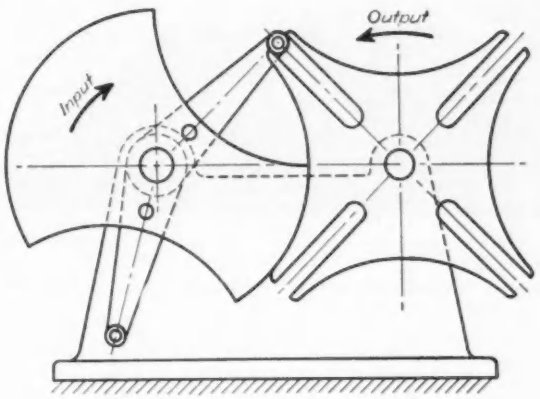


Fig. 5—(Below) In this intermittent drive, the two rollers drive the output shaft as well as lock it during dwell periods. For each revolution of the input shaft the output shaft has two motion periods. The output displacement ϕ is determined by the number of teeth; the driving angle, ψ, may be chosen within limits. Gear *a* is driven intermittently by two driving rollers mounted on input wheel *b*, which is bearing-mounted on frame *c*. During the dwell period the rollers circle around the top of a tooth. During the motion period, a roller's path *d* relative to the driven gear is a straight line inclined towards the output shaft. The tooth profile is a curve parallel to path *d*. The top land of a tooth becomes the arc of a circle of radius *R*, the arc approximating part of the path of a roller.

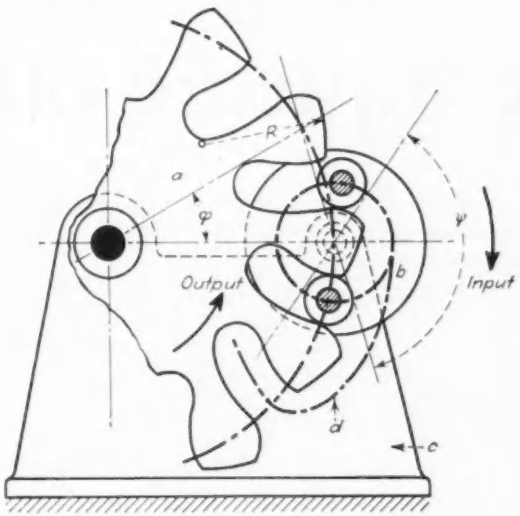


Fig. 4—(Left) The duration of the dwell periods is changed by arranging the driving rollers unsymmetrically around the input shaft. This does not affect the duration of the motion periods. If unequal motion periods are desired as well as unequal dwell periods, then the roller crank-arms must be unequal in length and the star must be suitably modified; such a mechanism is called an "irregular Geneva drive."

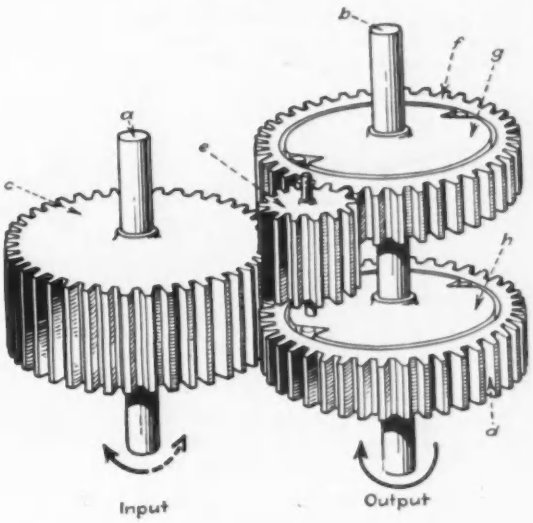


Fig. 6—This uni-directional drive was developed by the author and to his knowledge is novel. The output shaft rotates in the same direction at all times, without regard to the direction of the rotation of the input shaft; angular velocity of the output shaft is directly proportional to the angular velocity of the input shaft. Input shaft *a* carries spur gear *c*, which has approximately twice the face width of spur gears *f* and *d* mounted on output shaft *b*. Spur gear *c* meshes with idler *e* and with spur gear *d*. Idler *e* meshes with spur gears *c* and *f*. The output shaft *b* carries two free-wheel disks *g* and *h*, which are oriented uni-directionally.

When the input shaft rotates clockwise (bold arrow), spur gear *d* rotates counter-clockwise and idles around free-wheel disk *h*. At the same time idler *e*, which is also rotating counter-clockwise, causes spur gear *f* to turn clockwise and engage the rollers on free-wheel disk *g*; thus, shaft *b* is made to rotate clockwise. On the other hand, if the input shaft turns counter-clockwise (dotted arrow), then spur gear *f* will idle while spur gear *d* engages free-wheel disk *h*, again causing shaft *b* to rotate clockwise.

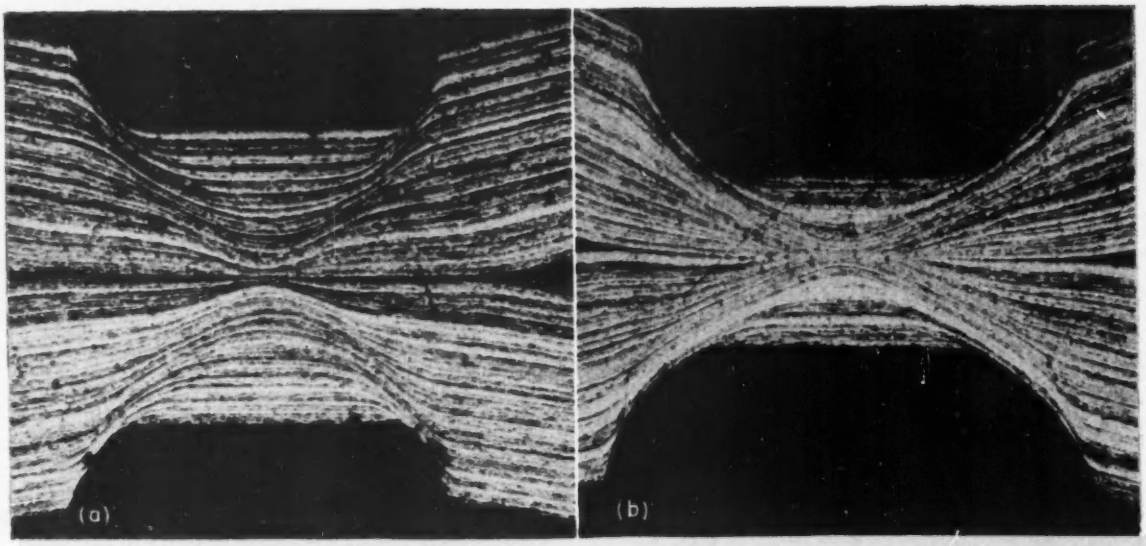


Fig. 1—Cross-sections of lap welds enlarged 20X to show the flow characteristics. They also emphasize the importance of using the proper amount of deformation. About 35 percent deformation was used in (a) and there is a true weld only at the center. In (b) the deformation was increased to about 60 percent and the weld area has increased by several times.

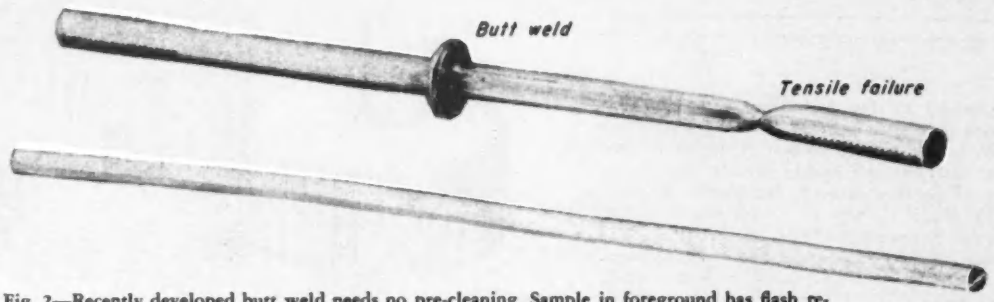


Fig. 2—Recently developed butt weld needs no pre-cleaning. Sample in foreground has flash removed and was drawn to a smaller dia. after welding. Location of weld cannot be seen.

Putting the Squeeze on

These are the first basic design data on cold welding that have been made available. Although primarily concerned with specific aluminum alloys, they incorporate a critical evaluation of the advantages and limitations of the process itself and indicate those factors which require additional study.

NORMAN GROSSMAN
Republic Aviation Corporation

UNTIL RECENTLY many reputable engineers and metallurgists insisted that it was not possible to weld two metallic surfaces merely by applying pressure. In a strict sense, they were correct. Cold welding involves more than applying pressure. It is based on a rigid analysis of the flow of metals and the development of special tools to produce the deformations required to direct this flow into a true weld.

The importance of this process, particularly as applied to aluminum, stems from the following advantages:

(1) Joints are efficient and, as shown in Fig. 3, often are as strong or stronger than the metals being joined. The reason is that the weld area does not have the cast structure characteristic of other welding processes, but is actually work hardened to some degree.

(2) Welds respond to heat-treatment if the parent metals do.

(3) Dissimilar materials can be joined, such as aluminum to copper, silver, lead or nickel.

(4) Thin sheets can be bonded readily to thick sections.

(5) Equipment is simple and inex-

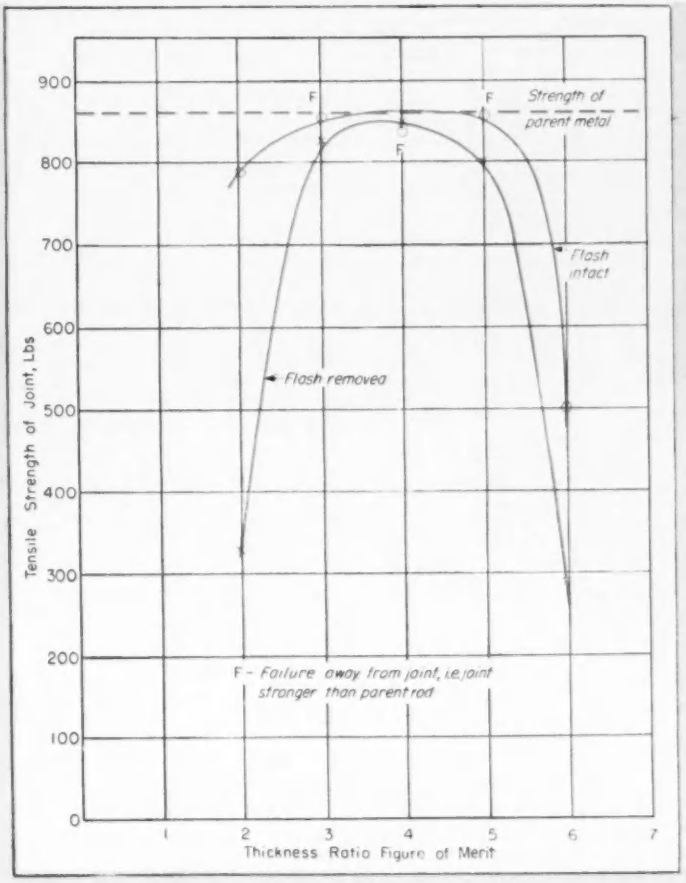


Fig. 3—Upper curves shows that strength of butt weld of ¼ in. electrical purity aluminum rod with flash intact is higher than that of parent metal. Mean strength of parent rod is 858 pounds. The abscissa represents various combinations of sheet thicknesses.

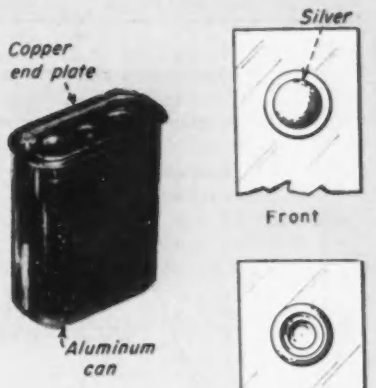


Fig. 4—Typical examples of dissimilar metals joints. Can (above) is a crystal container; Silver contact (right) is welded from rear to reduce the silver needed and improve bond.

Table I – Comparative Weldability of Aluminum

Alloy	Optimum reduction, per cent	Typical joint efficiency, per cent
3S-O	50	85–100+
3S-H14	70	70–85
3S-H16	70	60
3S-H18	60	55
4S-O	60	60
4S-H34	55	40
52S-O	60	65
Alclad 24S-T4	40	9–18
61S-T6	60	50
Alclad 75S-T6	40	10–15

These values are presented for comparative purposes only and are not intended for literal interpretation. Variations in tool dimensions would change the absolute values.

Cold Welding

pensive. Hand tools similar to conventional pliers can be used for small dia wire and thin sheets, conventional fly presses are satisfactory for thicker parts, and power presses are needed only for large and heavy pieces.

(6) Welder needs no special skill.

(7) Can be adapted to applications that are physically impossible with other forms of welding. Thin sections like aluminum foil, for example, cannot be welded by methods employing heat because of the danger of burning the foil. For the same reason, heat may be a disadvantage when welding thick to thin sections.

On the other hand, the principle factor that has limited the applications of cold welding to date has been the need for more fundamental data and the development work necessary to produce tools and procedures suitable for different types of applications. The basic factors which ultimately will determine the extent to which it can replace other methods of fastening include such parameters as surface preparation, weldable materials, allowable sheet thicknesses and deformations, bearing pressure, rate of application of pressure, and tool design. These will be discussed in detail. The principle basis of this discussion is a series of tests made at Republic Aviation under Air Force contract to investigate the possibility of using cold welding in aircraft structures. Therefore, these data apply to lap welds on sheets and structural alclad 24SO unless otherwise noted. Commercially pure grades have been used exclusively up to now because they are easier to weld. The basic principles, however, are the same—the primary difference being that the higher strength alloys are more difficult to weld since they require larger deformations.

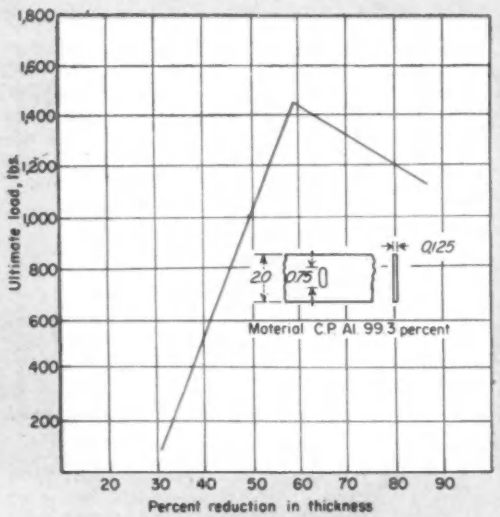
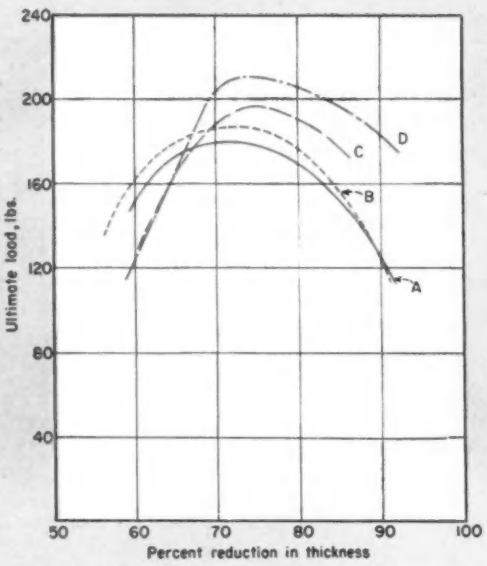


Fig. 5—Variation of ultimate load of single weld with percent reduction in total thickness for commercially pure grade of aluminum sheet-stock.



Curve	Tool Length	Thickness	Sheet thickness
A	0.325	0.064	0.040 X 0.040
B	0.325	0.064	0.040 X 0.051
C	0.325	0.064	0.051 X 0.051
D	0.325	0.064	0.040 X 0.064

Fig. 6—Typical data showing effect of percent reduction in thickness on the ultimate strength of the weld for 24SO aluminum alloy sheets. Concave shape of curves indicates there is an optimum value of percent reduction for each of the four cases.

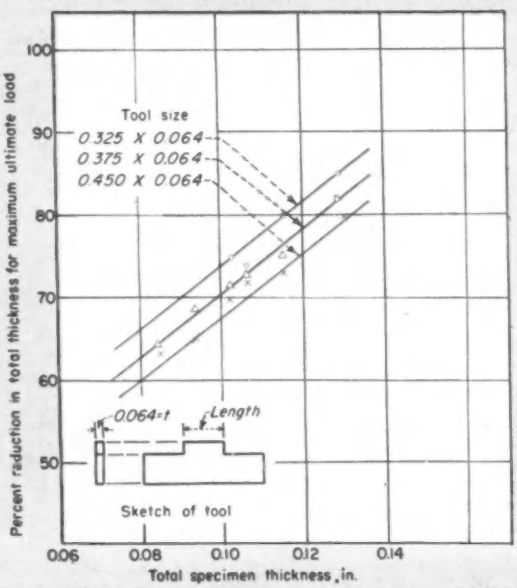


Fig. 7—Percent reduction in total specimen thickness for maximum weld strength is shown for different thicknesses of 24SO aluminum alloy sheet and the different tool dimensions indicated.

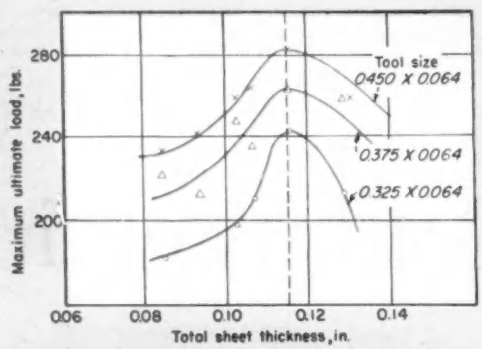


Fig. 8—Typical curves of maximum ultimate load vs total specimen thickness indicates that 0.0115 in. is the optimum total thickness for these tool sizes and rectangular welds on 24SO aluminum alloy.

Surface Preparation

Because the nature of this process is the forcing of metals to flow together to form a weld, the surfaces to be joined must be free from such contaminating elements as grease and dirt. For aluminum sheets, wire brushing to remove the oxide coating, is required. Chemical degreasing followed by wire rushing adds nothing in terms of strength. Also, surface preparations commonly used with spot welding have proved unsatisfactory.

As a general rule, it is desirable to weld as soon after cleaning as possible. Where care was taken to avoid contamination, however, satisfactory results have been obtained with time lapses of a day or longer.

As contrasted to the requirements for joining sheets, lead, copper and aluminum wire can now be butt welded as shown in Fig. 2 without a separate cleaning operation. This was accomplished by developing tools that trim the ends of the wires just before

welding to insure proper contact.

An interesting characteristic of cold welding is that poor quality bonds are almost impossible. If the surfaces are cleaned properly, sufficient pressure is exerted and a suitable die is used, a perfect weld will result, but if there is any degree of contamination, the parts will not bond and the operator will know at once.

Weldable Materials

Because the amount of deformation required to produce satisfactory bonds increases with stronger materials, practical considerations now limit the metals which can be cold welded. When the yield point exceeds about 30,000 psi, the strength factor of the bond falls off. Aluminum, copper, Duralumin, lead, nickel, and zinc have all proved applicable. Also, combinations of dissimilar metals such as copper to aluminum are now produced readily as illustrated by Fig. 4. At present the process is not particularly suitable for ferrous metals, although it has been demonstrated as a practical possibility. If strength is not important, as for hermetic seals, some alloys with yield points of about 50,000 psi can be joined.

The success with aluminum and its alloys is of particular importance because of the difficulties and expense associated with welding them by other means. Obviously, however, all aluminum alloys are not satisfactory in view of the previously mentioned restriction imposed on yield strength. For example, a series of tests on sheets of Alclad 24S-T3 a high strength, heat treated alloy, were all unsuccessful. Weld formations were obtained for sheet reductions of the order of 90 percent, but these were accompanied by cracking of the sheets in all cases. Similarly, the high yield strength of 75ST aluminum, about 70 ksi, eliminate it at present for load carrying parts. On the other hand, no difficulties were encountered with Alclad 24SO, an annealed aluminum alloy with a yield point of 14 ksi, in the combinations of tool size and sheet thickness described in following section. Table I gives a general comparison of the weldability of several common alloys.

As brought out in the previous section, the percent deformation is a critical factor. To analyze this parameter further, curves of sheet deformation are plotted against the ultimate strength of a single weld in Fig. 5, for a commercially pure aluminum and in Fig. 6 for 24SO in various combinations of sheet thickness. These curves are all concave downward, indicating that there is an optimum sheet reduction for which the weld strength is a maximum.

By cross plotting the data of Fig. 6 and similar formation for other tool sizes, Fig. 7 shows how the percent reduction in sheet thickness for maximum weld strength varies with sheet thickness for 24SO Alclad. Since these curves are parallel straight lines, it is seen that an increased percent reduction in thickness is required as the sheet thickness itself is increased. With commercial aluminum, this characteristic applies only when the thickness is about $\frac{1}{4}$ inch or more.

Graphs of the maximum weld strength verses sheet thickness for three tool sizes are plotted in Fig. 8. These curves have a maximum strength at a total sheet thickness of 0.115 in., indicating that the 0.064-0.051 in. combination is best for a rectangular tool 0.64 in. thick and this aluminum alloy. Although only 24SO was used to get the data in Figs. 5-7, similar trends—though different magnitudes—can be expected for other alloys.

Bearing Pressure

The basic requirement for bearing pressure is that it exceeds the yield strength of the material. The tool size and shape and the section thicknesses are the main factors that determine the degree by which this value must be exceeded.

The pressures required with 24SO aluminum for three different tool sizes are presented in Fig. 9 as a function of the percent reduction in sheet thickness. This indicates that total thickness rather than the thickness of the individual sheets is critical.

To investigate the effect of varying the rate of application of pressure, welds made in approximately five seconds were compared on the basis of ultimate load with welds made by extending the welding time to one minute. The same tool and deformation were used in both cases. The results of these tests indicate that pressure rate has no measurable effect on ultimate strength for the range tested.

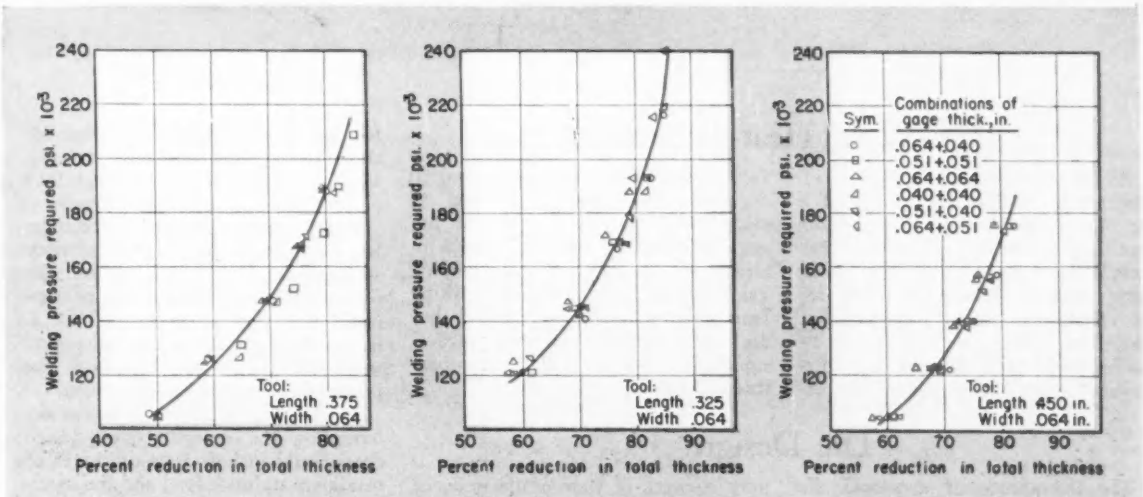


Fig. 9—Bearing pressures required to cold weld 24SO aluminum sheets are shown as functions of the percent reduction in total thickness. Fig. 4 gives the percent reduction for maximum strength.

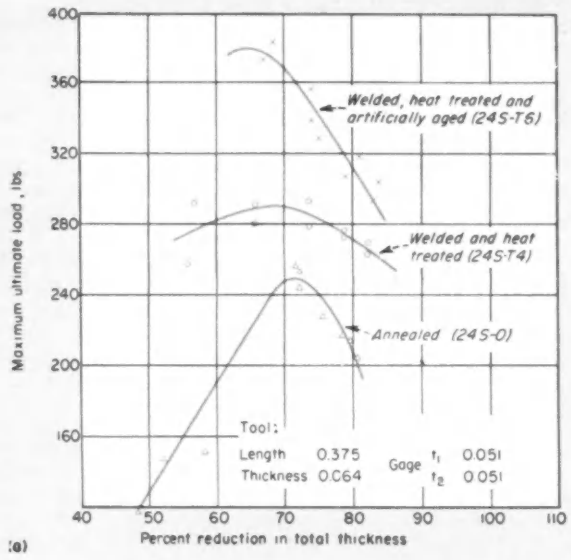


Fig. 10—Heat treatability of welds is shown in (a) for two 0.051 in. sheets and a rectangular tool 0.375 x 0.064 in. as compared, (b) to that of the parent material.

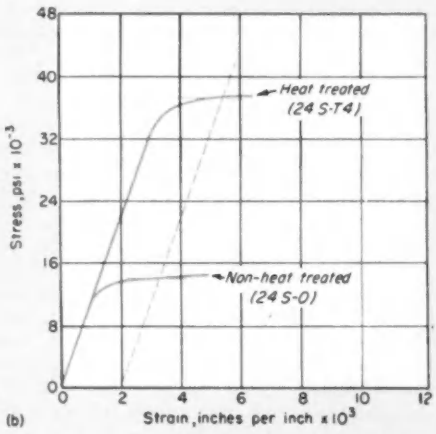
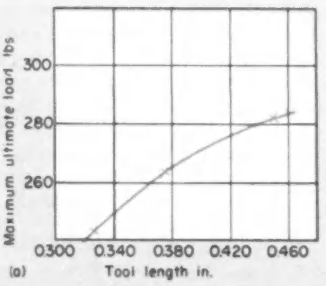
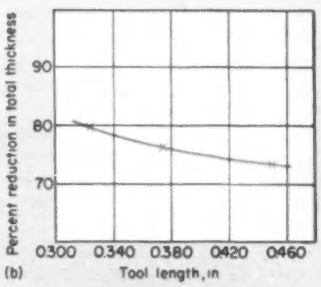
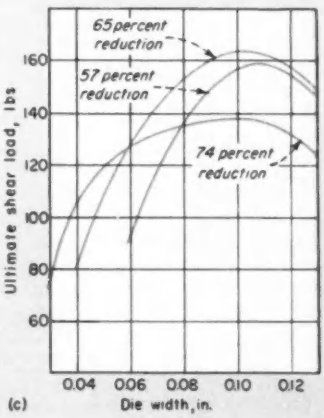


Fig. 11—Effect of tool length on load capacity is shown in (a) for 24SO aluminum sheets of 0.064 and 0.051 in. thickness. Variation of percent reduction in thickness for maximum load is given in (b) for the same sheets. Curve (c) shows the effect of tool width for commercially pure aluminum.







Post-Weld Heat-Treatment

As noted previously, one of the advantages of cold welding is that it is the only form of welding aluminum that shows any response to heat treatment. The properties of the parent metal remain unchanged except for the effects of a slight cold working. The data represented by Fig. 10(a) indicate that both solution and precipitation types of treatment are effective; the increases in static strength for these specimens are 16 and 52 respectively, over welds in the annealed condition. Although these increases are less than the corresponding gain in the basic material resulting from heat treatment, Fig. 10(b), they are large enough to have practical significance in many applications where this alloy is now being used.

Die Design

The importance of a proper die size and shape cannot be overemphasized. In general, the width must be chosen to provide satisfactory flow characteristics and the length must be controlled to provide adequate total joint strength in view of the reduced cross-sections. Fig. 11(a) and (b) show typical variations of maximum load capacity and percent reduction required for joining 24SO sheets 0.064 and 0.051 in. thick. Data for the effect of width variations for this alloy are not available, but Fig. 11(c) shows typical data for a 99.8 percent commercial aluminum.

A limitation to the use of rectangular welds, however, is their obvious suspectibility to fatigue cracks. To improve this rounded corners, as illustrated in Fig. 5, are preferred. Circular welds are now used on wires and small rods, Fig. 12, but have not proved suitable for joining sheets.

In general, the proper basis for determining the necessary tool design data should include a set of curves of maximum ultimate load and the corresponding percent reduction in sheet thickness plotted as a function of tool length or diameter for different thickness combinations. Additional data on the required press capacity can

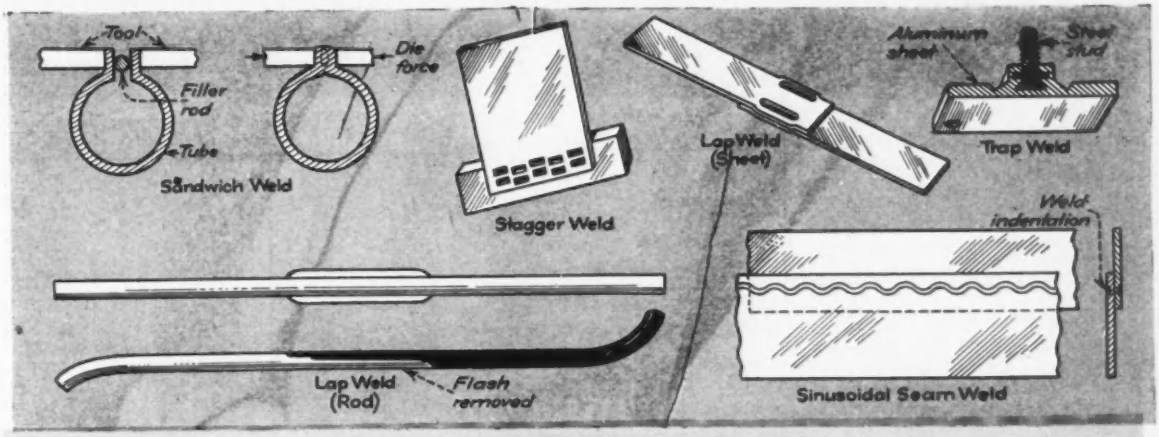


Fig. 14—Typical types of welds now being used. Others are being developed constantly.

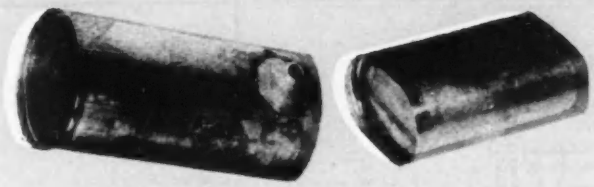


Fig. 13—Extrusion type welds on aluminum containers provide both strength and hermetic seals by using a step construction. Inner section gives strength and the outer portion is the seal.

Fig. 12—Al rods fabricated into mesh by using circular welds.

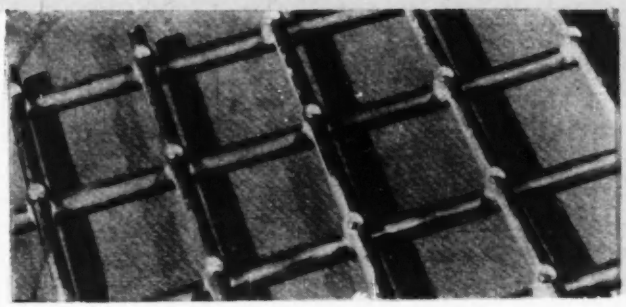
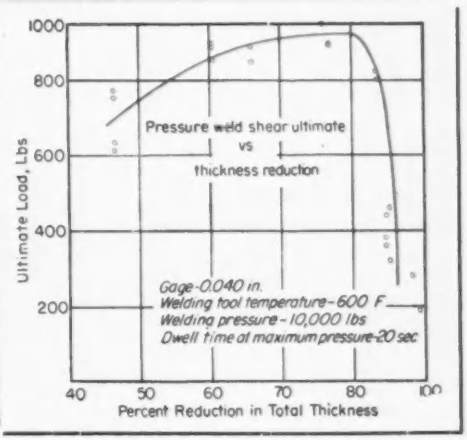


Fig. 15—Using heated dies on heat-treated aluminium alloy produces welds with 80 percent of the strength of the parent material. Room temperature bonds would carry only a small load, if any, using today's techniques.



be presented by curves of bearing pressure required for optimum reduction as a function of tool dimensions.

The importance of maintaining accurate tool alignment was also emphasized by these tests. Unless adequate support was provided, the upper tool shifted laterally with respect to the lower half, causing the sheet to rise on one side of the weld and to be depressed on the other.

For welding sections besides sheets, many other desirable weld shapes have been developed. Figs. 13 and 14 illustrate a few other types which are now being used. Others are being developed constantly to meet the needs of different applications.

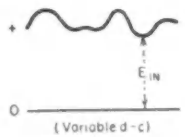
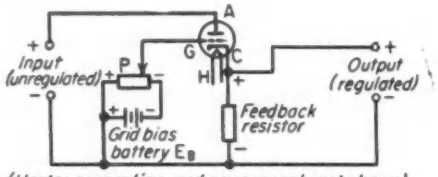
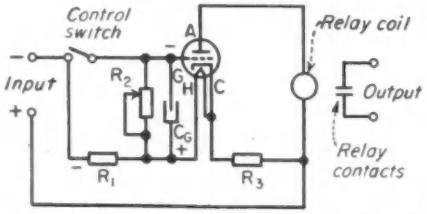
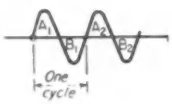
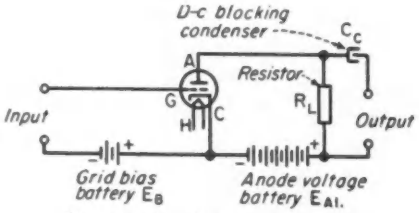
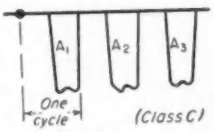
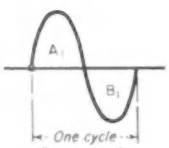
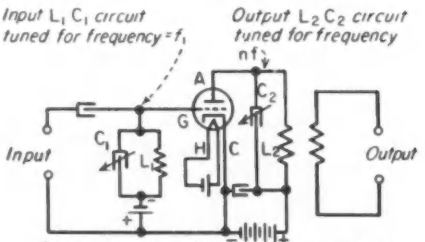
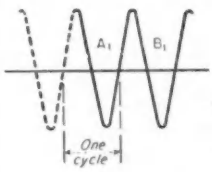
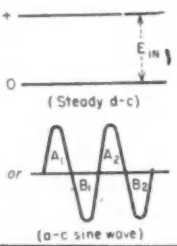
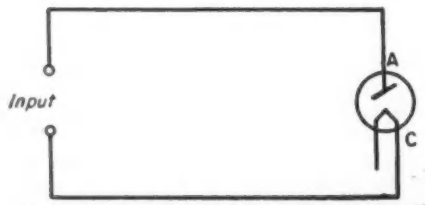
Because of its potential to replace more expensive and cumbersome methods, cold welding offers substantial economic advantages in many applications. Complete data to support this argument are not yet available.

Economically, the principal factors in favor of this method are the simplicity of the equipment required, the speed of the process and the elimination of the need for skilled workers. The dies in themselves are not expensive to produce since commercial steels are usually satisfactory and exacting tolerances are not required.

The future of this process is intimately related to the need for more fundamental research and the development of tools and procedures that are suitable for mass production use. For example, one factor that has been a disadvantage in some applications is the need for cleaning sheets by wire brushing. With high strength alloys of aluminum and other materials, the large percent reductions required to produce satisfactory welds restricts their use at present. One possible solution to the latter type problem may be the use of heated dies. As shown in Fig. 15, 24ST4 a heat-treated Alclad with a yield point of approximately 37,000 psi, can be welded satisfactorily if the dies are heated to 600 F. The maximum shear strength in a single weld of this type was 900 lb, or about 80 percent of the parent metal shear strength.

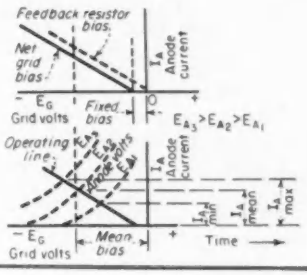
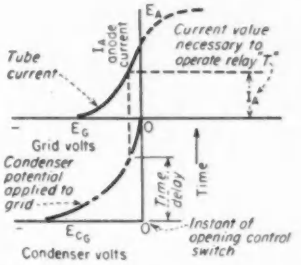
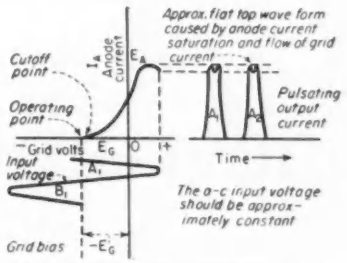
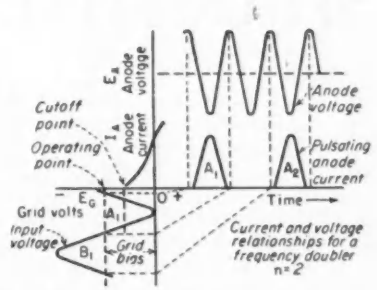
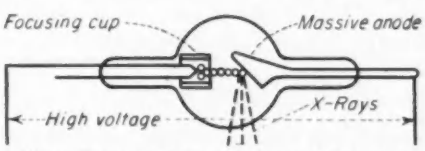
Acknouledgement: The author wishes to acknowledge his appreciation to the Koldweld Corp., 10 E. 40 St., New York, N. Y., for supplying many of the photographs and graphical illustrations, and to their parent organization, The General Electric Co., Ltd., of England, for their cooperation in the study that preceded the actual tests.

Fundamental Electronic Circuits — Tubes for Industrial

Type	Input Voltage	Circuit Sketch	Output Voltage
D-C Voltage Regulator		A = Anode G = Grid C = Cathode P = Potentiometer H = Heater  (Heater connection and power supply not shown)	
Electronic Time Delay		R = Resistor C_G = Grid condenser 	TIME DELAY PERIOD (Period from instant that control switch is opened until relay operates)
Generation of Rectangular Pulse		 (Grid bias for Class C operation) (Heater connection and power supply not shown)	
Frequency Multiplier		 (Grid bias adjusted for Class C operation)	
Production Of X-rays		 (Cathode connection and power supply not shown)	X-RAYS (Electromagnetic waves in a frequency range of approximately 10^{16} to 10^{20} cycles per second

Inspection and Control

RALPH B. IMMEL
Westinghouse Electric Corporation

Operation	Remarks
	The battery and potentiometer circuit supplies a fixed value of bias to the grid and determines the mean value of the regulated anode current. If the unregulated voltage input exceeds the regulated output voltage value, the anode current increases. This increases the negative bias and holds the current constant. Conversely, a decrease in input voltage will decrease the bias so that the current will increase. For a given input voltage variation the anode current I_A and the voltage drop across the feedback resistor will be approximately constant. The regulation is determined by the resistor value and the amplification factor of the tube. The output voltage of this type may not vary more than one volt for a 20 v change in input voltage.
	When the control switch is closed, the condenser C_g charges to a potential that is the same as the voltage drop across resistor R_1. The time delay period is initiated by opening the control switch which permits the condenser to discharge through the potentiometer R_2. The negative potential on the condenser and grid decays until the anode current increases to a value sufficient to operate the relay. The time period is the duration of time that elapses between the opening of the control switch and operation of relay. The time can be adjusted by varying R_2. The relay contacts can be either normally open or closed. It is seldom used for time periods exceeding one minute because of inaccuracies caused by condenser leakage. The reset time is almost instantaneous.
	The voltage pulse may be used for triggering or initiating operation in control circuits of apparatus. The circuit is similar to the pulse forming diode circuit except that the top of the wave form is flatter because of the flow of grid current. Peak-clipping or the generation of a rectangular alternating current voltage wave form can be obtained by using two tubes. The square wave form may then be used to check the performance of an amplifier or transformer.
	To obtain stable frequencies in excess of 10 megacycles, which is the practical limit for a crystal oscillator, a frequency-multiplier can be used. The input resonant circuit should be tuned for the input signal frequency and the anode resonant circuit should be tuned for an integral multiple of the input frequency. The anode circuit then offers a high impedance to the desired harmonic and a very low impedance to the fundamental and other harmonic frequencies. However, in the series resonant circuit the desired harmonic produces a voltage output that is predominant over that of any of the other frequencies. Frequencies of n times the fundamental or input frequency can be obtained with approximately $1/n$ times the power output of a normally operated Class C amplifier.
 When electrons which are moving at a high velocity strike a metallic target (anode), the impact will result in a radiation of short electromagnetic waves which are known as x-rays.	X-ray wave lengths are so short that they will pass between the lattice-like structure of elements and compounds. However, when they strike an atom they are deflected. Denser substances cast shadows on photographic film or on a fluorescent screen. X-rays provide a nondestructive means for medical examinations, inspection of industrial products, etc. The accelerating potential between the cathode and the anode is 300,000 v or more. As the greater portion of the energy of the electron stream is converted into heat when the electrons impinge upon the anode, the anode must be massive and suitable for conducting away the heat.

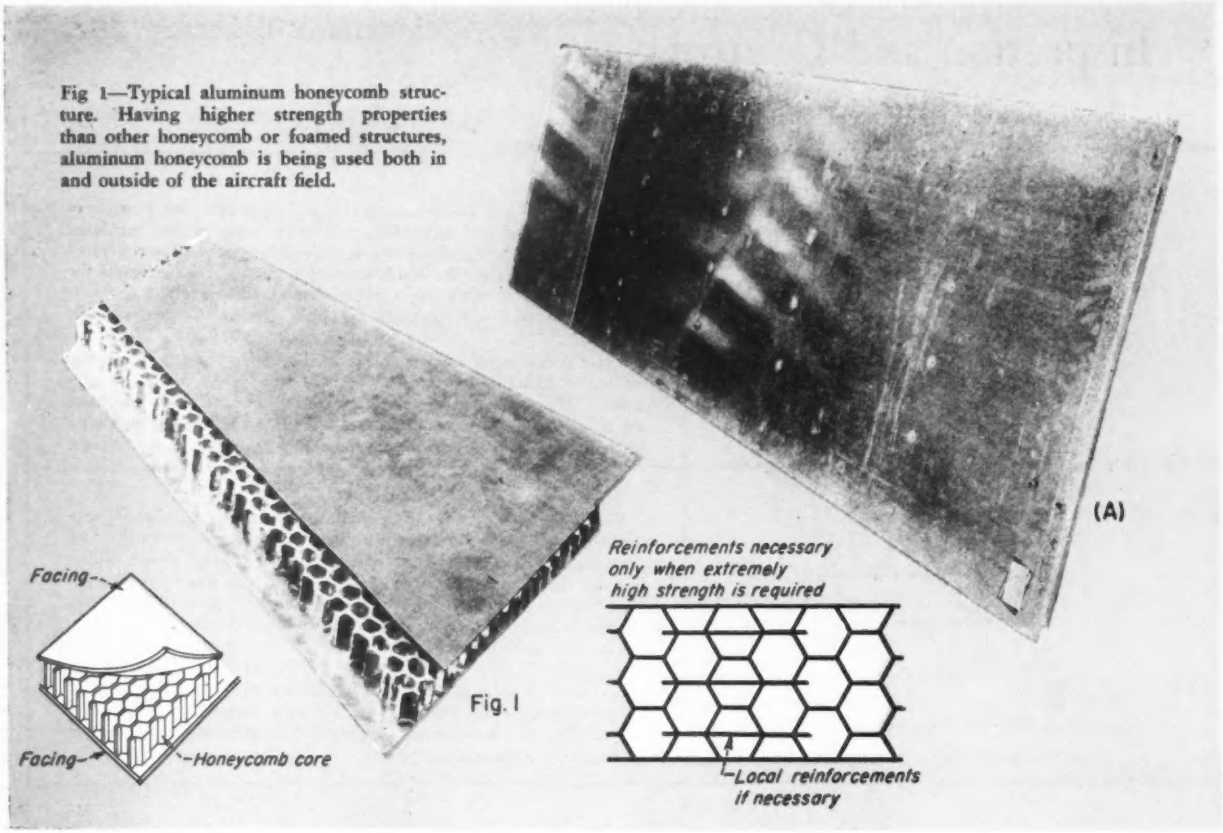


Fig 1—Typical aluminum honeycomb structure. Having higher strength properties than other honeycomb or foamed structures, aluminum honeycomb is being used both in and outside of the aircraft field.

Aluminum Honeycomb Sandwich Structures

THE AIRCRAFT INDUSTRY, which has pioneered the development and use of high strength, light-weight constructions, has in the past few years investigated several types of panel or sandwich members for both primary and secondary structures. First was the fabric honeycomb sandwich, which was developed by The Glenn L. Martin Company.

During this post-war period, interest also focused on foamed plastic reinforced structures (see *Product Engineering*, Oct. 1952) and on aluminum foil honeycomb sandwiches. This latter construction, also pioneered by the Martin Co., now is in quantity production for such parts as aircraft flooring, bulkheads, partitions, ducts, doors, ailerons, trim tabs, and leading edge slats, and for guided missile wings and radar reflectors.

Compared to fabric core honeycomb structures, aluminum foil has several advantages. Its high specific strength values in shear and compression, extremely high shearing modulus, resistance to corrosion and fungus growth, high strength under various environmental conditions such as extremes in temperature and humidity, and its availability in a range of densities make it adaptable to efficient design for many applications.

Except in some constructions such as specialized low density cores its compressive strength is higher than either foamed plastic structures or fabric core honeycomb, and can be more rigidly controlled than most foams. In addition, reinforcements can be added in the form of reinforcing strips through the center of the core to improve strength in localized sections.

Construction of the Sandwich

A structural aluminum sandwich consists of two high strength thin facings separated by a low density aluminum foil core. The core and facing are bonded with heat and pressure into an integral panel using a thermosetting synthetic resin adhesive.

The core, which is being produced under license by Honeycomb Company of America, Bridgeport, Conn., U. S.

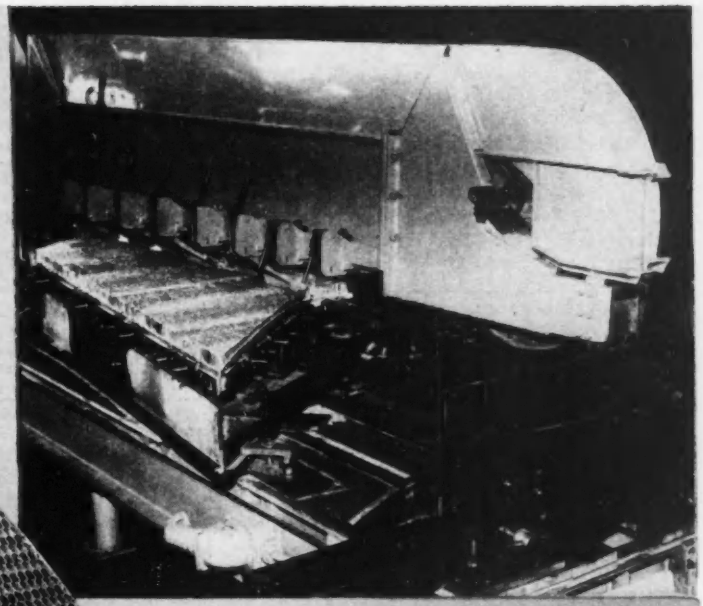


Fig. 2—Horizontal band saw used in contouring the honeycomb core. However, for slicing flat sheets of core, a regular high speed band saw is preferred and always used. Tolerances on the order of ±0.005 in. or better are practical on production runs.

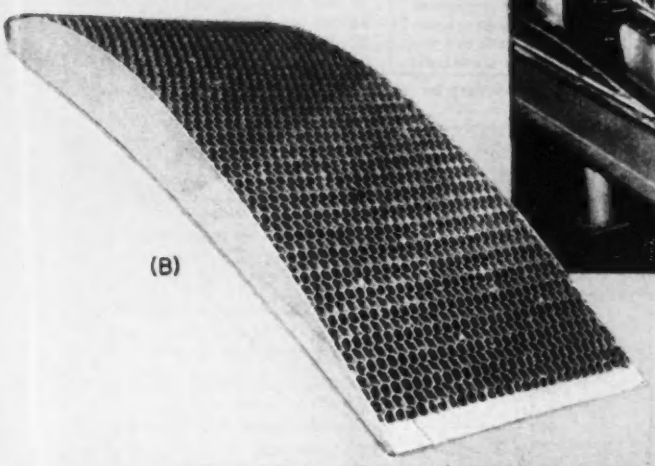


Fig 3—Straight aluminum honeycomb panel (A) with reinforced edging, spliced section, and inserts for attachments; and (B) airfoil sections as might be used for aircraft or missile structure. The method of producing these latter sections is discussed thoroughly in the text and shown in subsequent illustrations.

Developed several years ago by The Glenn L. Martin Company and now in quantity production for aircraft and guided missile use, aluminum honeycomb-aluminum facing sandwiches have application potential whenever (1) a high strength to weight ratio and/or (2) high rigidity structures are required. Construction, application, and design data presented herein have been supplied by the engineering department of Glenn L. Martin and are aimed at establishing parameters of use not only in aircraft but in other fields. Included are data on construction, process control, effect of density on crushing and shear strength, and typical design and joint details.

Plywood Corp., N. Y. C, and Aircraft Die Cutters of Los Angeles, Calif, can be obtained in $\frac{1}{4}$, and $\frac{3}{8}$ in. hexagon cells, and experimentally, in $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ in. cells. The greater the cell density, of course, the higher the strength; conversely, the lower the density, the more economical is the construction. With the larger cell sizes, the bond strength suffers somewhat but, using a dry film adhesive, is sufficiently strong for many of the aircraft applications.

Foil is fabricated of 3-S aluminum in H-18 or H-19 condition and must meet minimum strength requirements of 19,000 psi. Thicknesses range from 0.001 to 0.006 in. ± 10 percent; with heavier gages, there is some danger of spring-back and nonuniform bonding. This foil, chemically clean, is run through a series of piercing rolls, an operation necessary to provide vents for escape of the gases during curing of the adhesive. The foil is then flattened and corrugated, after which adhesive is applied to the crest on one side and then on the other. Next the foil is layed crest upon crest, and cured at temperatures on the order of 300 F.

The facing material, also bonded by a phenolic adhesive, is next applied. Here aluminum—either 24S-T3 or 75S-T6—is preferred because of its high strength and light weight. The thickness varies from 0.012 to 0.125 in., although lighter gages (0.016, 0.020, 0.025, and 0.032) are more frequent in aircraft applications. The heavier gage facing frequently is used on the compression side of panels with high bending moments. Floor panels in all cases should have heavier gage facings on the walking side with a minimum of 0.020 in. for covered or light panels and from 0.032 to 0.064 in. for heavy service conditions on exposed surfaces. Bottom facings are 0.016 inch for average service conditions.

Magnesium facing is not as durable as aluminum facing and will not absorb concentrated load shocks as well. It is not recommended for flooring as it is easily damaged, but it may be used for partitions and panels which are lightly loaded.

Plywood facings are not generally satisfactory for stressed panels, but

Table I—Nominal Densities and Properties of Aluminum Honeycomb Cores

Nominal Foil Thickness, in.	Nominal Core Density*		Mechanical Properties				
				Shear Strength, psi		Modulus of Rigidity, psi	
	Lb/cu. ft.	Lb/cu. in.	Crushing strength, psi	Parallel to Core	Perpendicular to Core	Parallel to Core	Perpendicular to Core
0.002	2.98	0.00172	Curves for these values are reproduced below. Values are minimum —not recommended design values —and while proposed, have not yet been accepted as industry standards.			24,000	9,500
0.003	4.18	0.00242				35,000	15,000
0.004	5.36	0.00310				95,000	25,000
0.005	6.54	0.00378				70,000	23,000
0.006	7.74	0.00448				93,000	23,000

* Due to variations encountered during manufacturing, weight may vary by ±6.0 percent

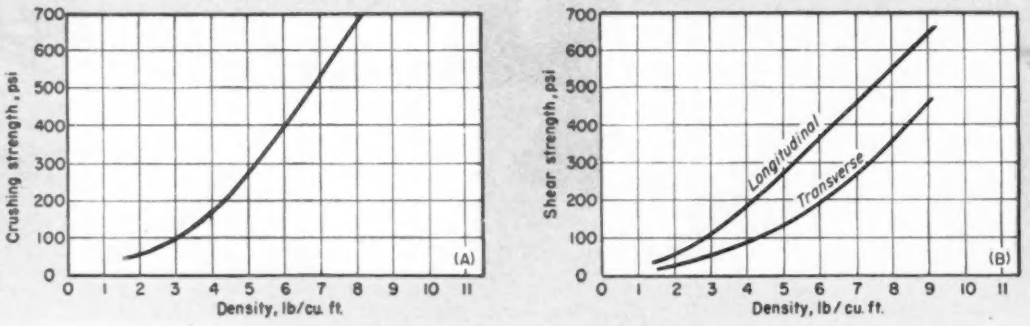


Fig 4—Effect of core density on crushing strength (A) and shear strength (B) of aluminum honeycomb cores. Curves are minimum requirements as specified in Aircraft Industries Assn Report ARTC-5, Sept. 1952.

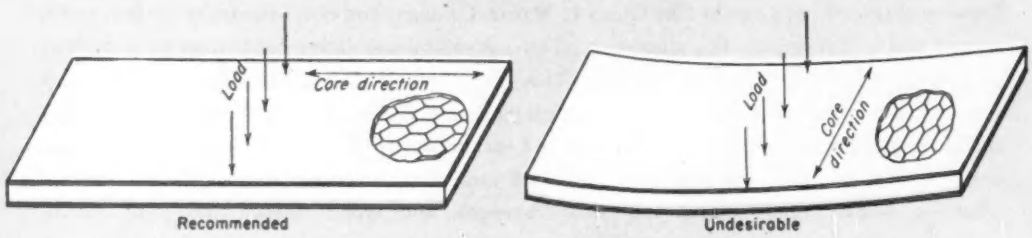


Fig. 5—Recommended direction of cores for honeycomb panels. Shear strength is approximately twice as high when loading is parellel to the cell axis, and even greater in the side direction.

stainless steel has been used for such applications, and also for facings on propellar blades. In only rare instances would facings other than metal be used with aluminum cores, since the function of the facing is to provide stiffness, stability, configuration and strength to the sandwich, and in some cases, surface smoothness or abrasion resistance. However, phenolic cloth laminates or glass fiber laminates are satisfactory with aluminum honeycomb wherever a non-metallic surface is required for abrasion resistance or electrical insulation. In any case, since the strength of the structure depends considerably on the face these facing sheets must be free from wrinkles, dents and other surface defects to prevent premature failure.

The ratio of core to facing thickness of the sandwich panel varies with its functional requirements. Where rigidity is of primary importance the ratio of thickness of core to thickness of panel is generally about 0.95. Panels that carry bending stresses primarily, such as floor panels, can be designed with the compression or top side of a heavier gage than the tension or bottom side. This ratio of top facing to bottom facing should not exceed 2 to 1.

Facings of different materials should not be used on a sandwich panel that is bonded with heat as the different rates of thermal expansion will cause the panel to warp upon cooling.

The honeycomb is cut to the desired thickness, of course, prior to the face bonding operation. This cutting or slicing operation is performed on a horizontal band saw, Fig. 2, for contoured panels. For slicing flat sections, a standard vertical high speed band

saw is used. Tolerances on slicing can be held to ±0.005 in. or better whether the core is straight, contoured (Fig 3) or tapered.

Contoured honeycomb panels are normally bonded by bag or blanket molding in an autoclave at pressures ranging from 20 to 100 psi, or in an oven under a vacuum pressure of approximately 14 psi. In bag molding, the assembly is placed in a bag of neoprene coated fabric and sealed. A vacuum is applied and the bag is placed in the oven or autoclave. Blanket molding consists of using a neoprene coated fabric blanket sealed to a metal plate or metal contour tool with zinc chromate paste or by clamping action. A vacuum is applied and procedure as for bag molding followed. Slightly contoured panels can also be bonded in a press, but expensive dies are required.

Panels can be bonded of single or double curvature with formed aluminum foil core of constant or tapered thickness. The facings are pre-formed to contour and the core formed by hand to the contour of the facings. The panel is then bonded by methods described above. Examples of this type panel are wing covers and blankets, stabilizers and fin blankets, leading edge assemblies, and fuselage panels.

Panels of any desired length or width can be made by splicing the core. When the splice is perpendicular to the core direction, one method is to nestle the crests of one slice of the core into the valleys of another. Longitudinal joints are made by interlocking the edges of core sections. Each lamination must be overlapped to provide core continuity, but the location and nature of core splices usually need not be indicated on a drawing unless they are structurally critical. If critical, they should be outlined and a note added to that effect.

The adhesive, a vinyl phenolic developed by the Martin Co. and made by Bloomingdale Rubber Co., and U. S. Plywood Co., is used to bond together both the honeycomb shaped foil segments and to bond the core to the facing sections. It develops high shear and tensile strength, has good creep resistance at temperatures up to 160 F, has good resistance to humidity, and is relatively insoluable in organic solvents. In the past, the adhesive was normally brushed or roller coated on the core to a weight of about 8/100 lb per sq ft, and was sprayed on metal facings. But the dry film adhesive is proving more economical and is producing bonds of higher quality, and therefore is gradually being more widely adopted for many of the various aircraft structures.

Properties of Aluminum Honeycomb Panels

Mechanical properties of aluminum honeycomb structures are governed by several variables: gage of the foil, cell size, gage and type of facing material among others. However, since strength varies directly with core density, this factor is used in preliminary calculations aimed at establishing core specifications. From Table I, nominal core density can be obtained for various thicknesses of foil. These can be related to properties as shown in the table or in Fig 4.

As will be noted from the curves, the core has directional properties. Both the shear strength and shearing modulus are higher—approximately 1.8 times—with the core direction parallel to the panel than across it. This results in lower shear deflection and higher strength, the opposite of which would prevail with the core direction perpendicular to the span.

Higher compressive strengths can be obtained by densifying the core or by cell reinforcement, Fig 6. The first method, which is often used at the edge of panels to resist edge damage, consists of crushing the cells into a solid mass.

The second method consists of running a reinforcing strip through the center of the core. An increase of about 100 percent in compressive strengths is obtained parallel to the cell axis. An irregular pattern is often specified for such reinforcements in order to obtain a better distribution of applied stress. The reinforcement is a strip of soil of a heavier gage or the same gage as the core, and is made of the same material. Most prevalent use of this type of reinforcement in aircraft would be in floor panels where they pass over supports, or in the leading edge section of a wing where the molding pressure would not be parallel to the cell axis and thus tend to crush the core from the side unless it were reinforced.

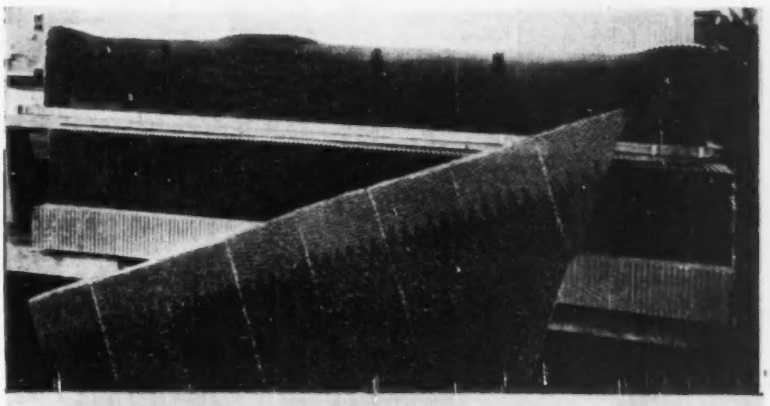


Fig 6—Two methods of increasing strength in localized areas: (Below) crushing or densifying the core; and (above) reinforcing the core with stringers through the center. (See also Fig 1). Note the irregular pattern in panel in the foreground above, and the contour of the top structure.

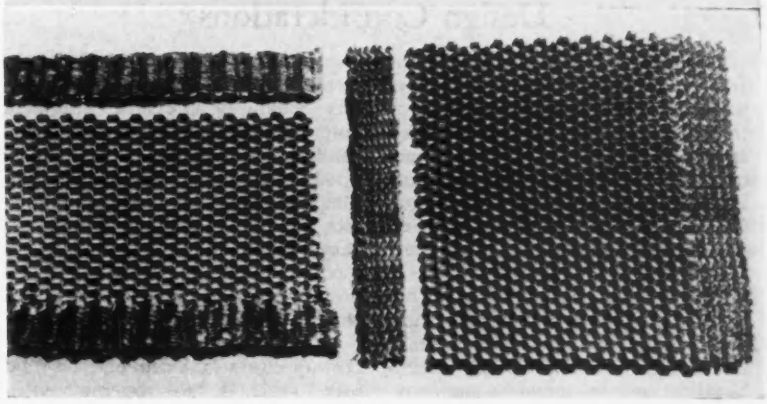
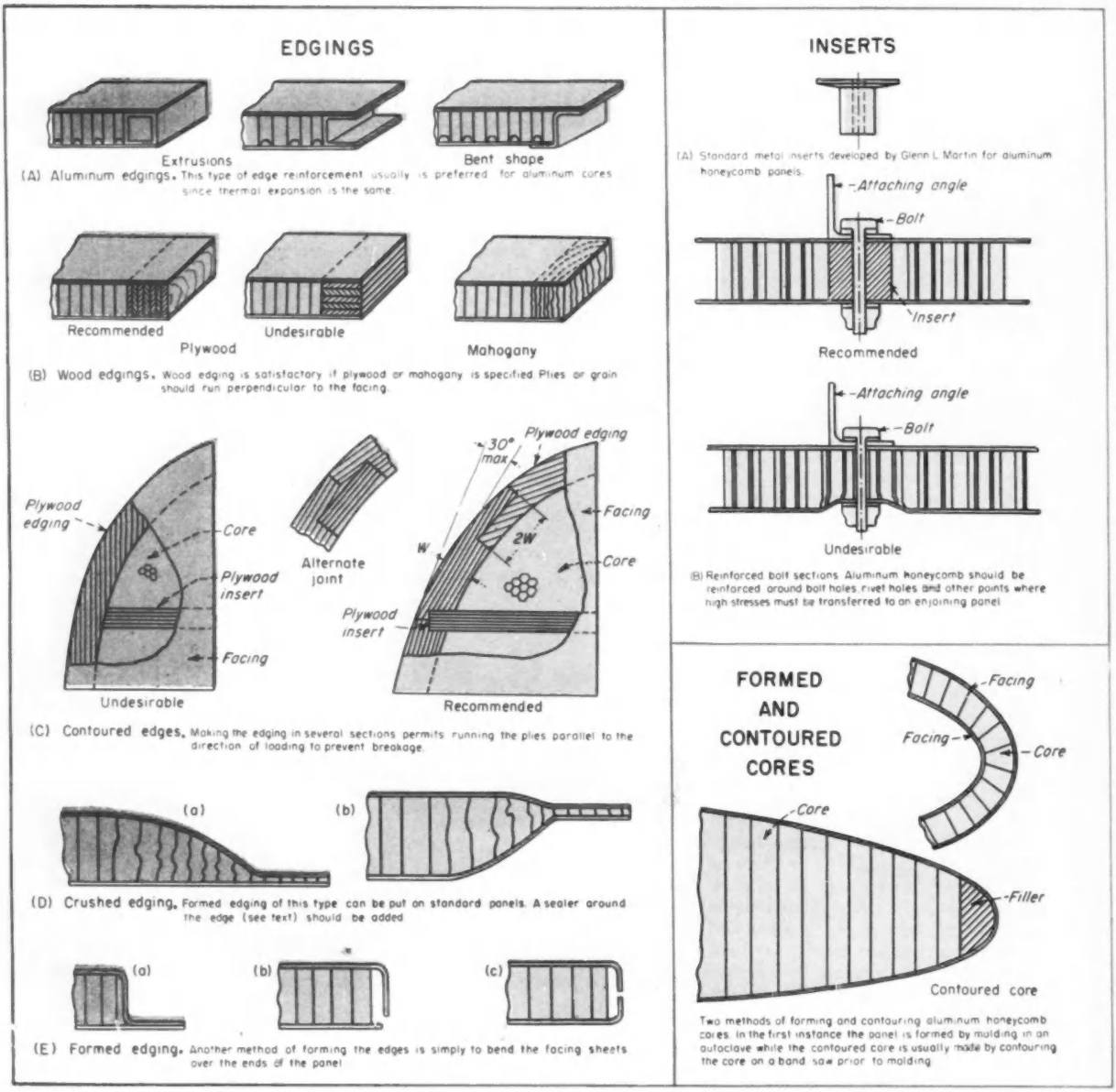


Table II — Design Details for Aluminum Honeycomb Structures


EDGINGS
Extrusions
Bent shape
(A) Aluminum edgings. This type of edge reinforcement usually is preferred for aluminum cores since thermal expansion is the same.
Recommended
Undesirable
Plywood
Mahogany
(B) Wood edgings. Wood edging is satisfactory if plywood or mahogany is specified. Plies or grain should run perpendicular to the facing.
Plywood edging
Core
Plywood insert
Facing
Undesirable
Alternate joint
30° max
Plywood edging
Facing
W
2W
Core
Plywood insert
Recommended
(C) Contoured edges. Making the edging in several sections permits running the plies parallel to the direction of loading to prevent breakage.
(a)
(b)
(D) Crushed edging. Formed edging of this type can be put on standard panels. A sealer around the edge (see text) should be added.
(a)
(b)
(c)
(E) Formed edging. Another method of forming the edges is simply to bend the facing sheets over the ends of the panel.
INSERTS
(A) Standard metal inserts developed by Glenn L. Martin for aluminum honeycomb panels.
Attaching angle
Bolt
Insert
Recommended
Attaching angle
Bolt
Undesirable
(B) Reinforced bolt sections. Aluminum honeycomb should be reinforced around bolt holes, rivet holes and other points where high stresses must be transferred to an enjoining panel.
FORMED AND CONTOURED CORES
Facing
Facing
Core
Core
Filler
Contoured core
Two methods of forming and contouring aluminum honeycomb cores. In the first instance the panel is formed by molding in an autoclave while the contoured core is usually made by contouring the core on a band saw prior to molding.

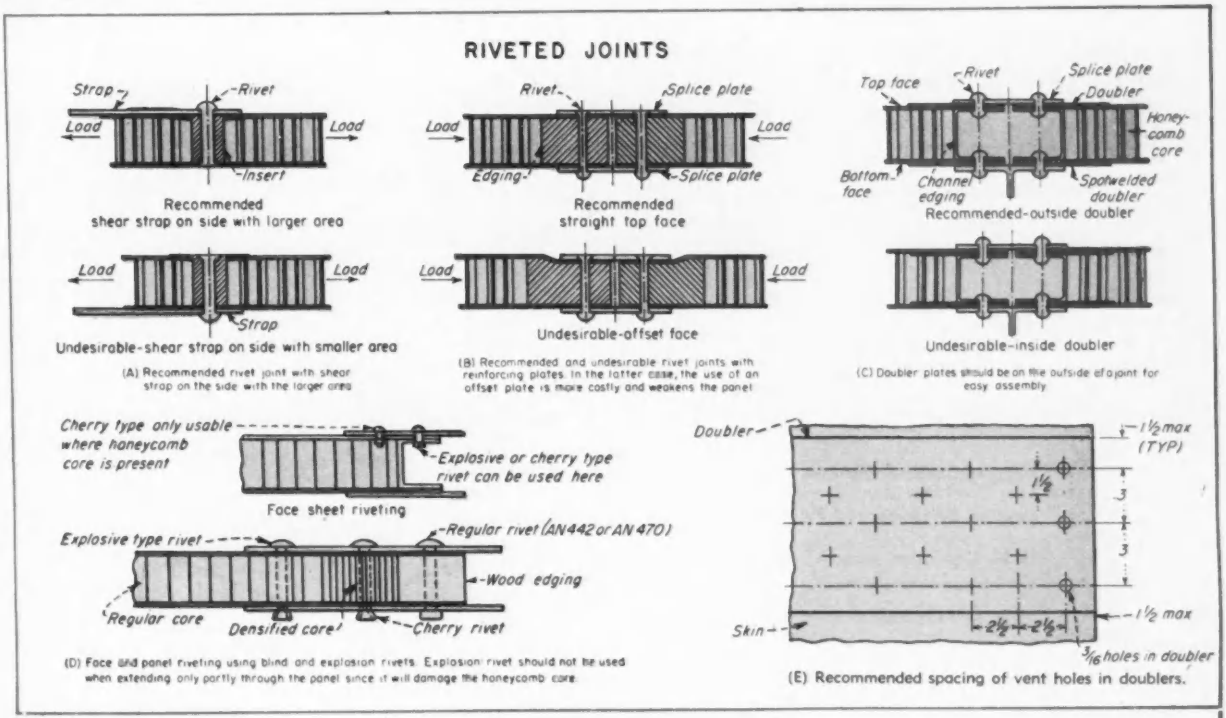
Design Considerations

In attaching sandwich panels to the framework of aircraft or to similar parts, facilities must be provided for transferring the stresses concentrated at these attachments. In most structural applications, local reinforcements are incorporated during fabrication. On lightly stressed parts, however, subsequently inserted reinforcements are satisfactory.

Edgings—Panel edging is used between the panel faces for appearance, protection of the core from moisture and foreign matter, protection during handling, and to provide a means of installation. When edge reinforcements extend all around the panel, they should be provided with vent holes for the escape of gases during bonding. These vents should later be filled with plastic wood or sealing compound *EC* 801, made by Minnesota Mining and Manufacturing Company. This same sealing compound is used when no edge reinforcement is necessary or when the core is densified around the edges.

Aluminum edgings in the form of bent-up channels, extrusions, or solid bars, Table II, are the most satisfactory for aluminum faced panels. Wood is somewhat less satisfactory than metal because of its different expansion rates under heat. After bonding, a stress is set-up in the metal facing due to the inability of the wood to contract upon cooling. This sometimes causes buckling or wrinkling in panels having long and/or discontinuous edging. The wood that produces the least stress is end-grain mahogany. Plywood, with plies normal to the metal facings, is also satisfactory; poplar plywood is preferred because it is lighter and cheaper than the mahogany type.

Flat panels with contoured edgings



present special problems when plywood is used with the plies perpendicular to the facing. It is possible that on long, narrow edgings with a large amount of contour, the plies eventually line up across the width of the edging instead of lengthwise. This gives rise to excessive breakage of edging strips during fabrication of the panel. Therefore, on long contoured edgings, it is advisable to make them up of several pieces, none of which has an angle greater than 30 deg between the plies and a tangent to the contour. On drawings note that all the wood edging in contact should be glued together in sub-assembly or notched and stapled together prior to bonding.

Phenolic edging is heavier and more costly than wood. However its thermal expansion rate is closer to that of aluminum and thus less stress is produced in the facings when bonded to metal. High compressive strength makes it a satisfactory edging for attachment purposes.

The use of densified core for edgings increases the resistance of the panel to local crushing such as encountered in a floor panel over its supports. It is not satisfactory, however, for use in making attachments unless washers or backing strips are provided to distribute high local crushing forces. The edging is either a separate piece of core densified and laid in the core blanket, or the core itself can be made oversize and densified along its edge during fabrication. Densified core which follows a contour or forms a ring around a hole must be a separate part.

Formed edging thus can be made by crushing the edge of the sandwich panel or by forming one or both facing sheets along the edge of the panel. The advantage of the first method is that standard panels can be used, detail fabrication and special tooling is eliminated, and a substantial reduction

Table III—Tolerances for Sandwich Panels of Aluminum Core

Type of Part		Tolerance, in.
Nominal Core Thickness		+0.010 −0.000
Edgings and Inserts	Wood	±0.005
	Extrusions—Channels & Zees	±0.010 ±0.000
	Drawn Tubing	−0.008
	Alumining Bar, Phenolic Inerts, Molding Stops	+0.000 −0.004
	Bent-up Channel—Interior	+0.000 −0.016
	Bent-up Channel—Exterior	+0.016 −0.000
	Bent-up Zee or Formed Facing	±0.016
	GLM 21-5 Insert Length	+0.000 −0.010
Overall Panel Thickness	Press Molded Panels—	±0.010
	Bag Molded Panels Max—Waviness in 3 ft Equal to Facing Thickness	±0.020

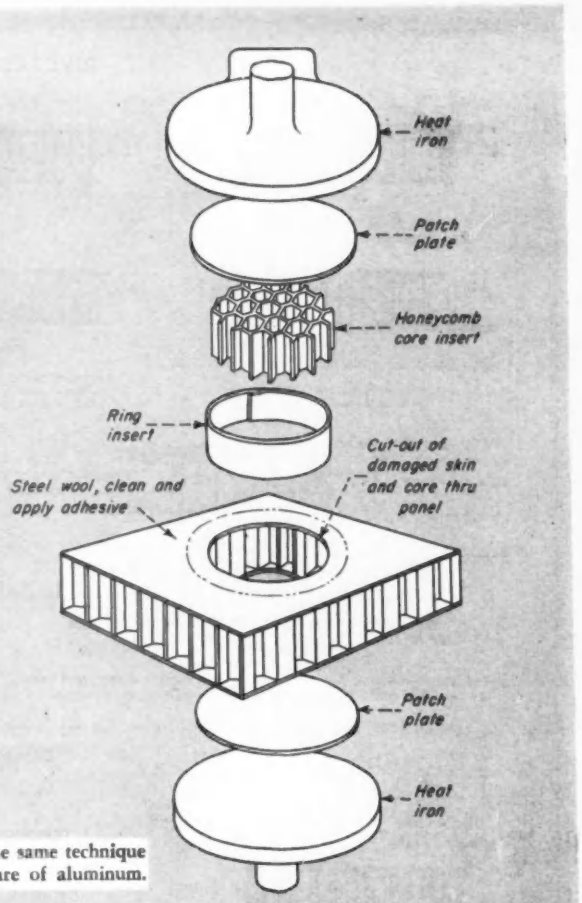


Fig 7—Method of repairing damaged sections. This is the same technique as used for fabric honeycomb cores except that parts are of aluminum.

in cost is realized. On the other hand, panels with formed facings provide good resistance to damage by peeling; Type *c*, Table II, has a special advantage in that it does not require the use of locating jigs during the bonding operation.

Inserts—Inserts may be in the form of strips or local reinforcements under individual bolt or rivet fittings.

A standard metal insert used by Martin, (Table II) is available either with a solid shank or drilled and countersunk; plain inserts may be drilled and tapped on assembly. Wood inserts may be of the same type as wood edgings. However, small solid end grain plugs of low density woods—such as poplar or spruce—can be used. Small inserts of plywood (10 sq. in. or less) may be set in with plies parallel to the facings since the relative short length prevents an excessive build-up of facing stresses during cooling. Inserts of mahogany having the grain of the wood parallel to the panel faces may be used if the insert does not exceed approximately 10 in. across the grain and 5 in. with the grain.

In view of their high compressive strength, phenolic laminates are also satisfactory as inserts for bolted and riveted attachments. Laminates should be placed parallel to the facings, and the material should be specified as laminated phenolic sheet, Grade *C*, Type FBM in military specification MIL-P-15035.

Metal and phenolic inserts provide the best resistance to crushing when used with bolted attachments. Careful analysis of loads should be made for bolting through wood inserts.

Due to methods of upsetting their heads which cause local crushing action, regular and Cherry Blind Rivets cannot be used to rivet through a panel unless a solid metal or phenolic edging is present. Riveting thru wood edging is marginal and requires care for satisfactory results. Through explosive type rivets can be used with honeycomb core. Cherry type rivets can be used where densified core is present and facings are relatively heavy, i.e., 0.040 to 0.064 inch. Blind rivets also can be used to rivet through one facing. Explosive types are satisfactory when riveting a facing sheet to a channel or tube edging, or as noted above, for riveting through the entire panel; they should not be used, however, for riveting through a facing sheet into a core, as the explosive charge will damage and weaken the honeycomb.

Doublers—Doublers are used for developing the strength of the panel in bearing at the attachments and also to increase panel strength locally.

Spotwelded doublers should be on the outside of the sandwich panel. With the spotwelded doubler on the inside, a portion of unsupported panel facing between the doubler edge and first row of spotwelds results, causing local failures in the facings.

Where a flush panel surface is necessary, a bonded type doubler must be used between the facing and core.

Table IV—Process Control for Aluminum Honeycomb Structures

A. DETAILS

1. Inspection of core details, prior to adhesive application, for proper material and core thickness as specified by the engineering drawing.
2. Inspection of edging and insert details, prior to adhesive application, for proper thickness and size dimensions.
3. Inspection of complete core blanket assembly for bond between core slices and between core, inserts and edgings.
4. Inspection of facing and doubler thicknesses and size, prior to adhesive application.
5. Inspection of the fit of individual details to the assembly and to the tool prior to adhesive applications.

B. CLEANING AND ADHESIVE APPLICATIONS

1. A check should be maintained on the cleaning and spraying procedures by weekly or semi-weekly tests conducted by Quality Control on shear specimens processed along with production parts. Test should be conducted in accordance with paragraph 4.3.3.1. of Air Force Specification No. 14164, "Adhesive, Metal-to-Metal, Structural". Minimum strengths should be established by the materials laboratory.
2. Inspection of adhesive coating on facings and other detail parts for smoothness, absence of blushing, proper thickness and area covered.
3. Inspection of adhesive coating on the core for proper bead size.
4. Detail parts should be coated as they are needed for bonding. However, coated detail parts which are not immediately bonded are wrapped and dated. A stock control should be established to assure that stocked adhesive coated details are not overaged and that earlier dated parts are used first.
5. Education of personnel on proper handling of details to avoid damage and to avoid contamination of adhesive and coated details from dirt, dust and foreign matter.

C. PRE-CURE OF ADHESIVE

1. Inspection for proper air dry.
2. Inspection for force dry schedule where required.
3. Provision in shop area must be made for proper removal of solvents which are toxic and inflammable in nature.

D. BONDING

Control of bonding operation should be obtained through the following methods:

1. Inspection at the assembly station to assure that only inspected and accepted details are admitted into the bonding equipment.
2. Inspection during the bonding operation to assure that bonding pressure, temperature and time requirements are being met. Records must be kept of this step.

E. FINISHING

1. Inspection for cleaning and edge sealing of panel as required by the process and/or drawing.
2. Inspection for finish as required by the drawing and/or applicable Finish Specification.

F. FINAL INSPECTION

1. Inspection of panel size and thickness to drawing requirements.
2. Inspection for quality of bond.
3. Periodic sampling of production parts for ultimate strength tests to determine actual strength properties.

Best design practice should call for flat or press molded parts to have doublers on the inside, and for bag molded parts on the outside of the facing.

Multiple bonded doublers should be avoided if possible by means of a thick doubler with tapered edge, especially for bag molded panels. In dimensioning core and total panel thickness, glue line thickness between multiple doublers should be taken into account.

All internal doublers of a bonded width of 3 in. or greater, and all internal laminations of a laminated facing should have 3/16 in. diameter holes spaced at approximately 3 in. in a staggered pattern to allow for the escape of gases during bonding operation. This prevents the formation of "blisters" or unbonded areas. The edge distance for the first row of holes in the pattern should be a maximum of $1\frac{1}{2}$ in. In multiple layer doublers or multiple laminated facings, hole patterns should be identical so that none of the interior holes are sealed off entirely. See Table II.

Tolerances—Tolerances play an important role in sandwich structures. The quality of the bond is determined by the amount of contact between the surfaces at the glue line. Thus if an insert or edging is oversize or undersize beyond tolerances specified, poor contact will result in some of the surfaces of facings and core and the panel will not develop full strength.

Table III shows tolerances allowed for sandwich panels which result in well bonded panels. These tolerances are based upon the latest recommended practices, and should be specified for all newly designed parts.

Deviation from above tolerances for press molded parts may affect the structural integrity of the panel since lack of sufficient molding pressure may exist. For bag molded parts where uniformly distributed pressure is exerted during molding the above tolerance must be used for details, however, the final panel thickness may vary to ± 0.020 in. provided that no abrupt changes in thickness occurs. The maximum permissible waviness in the facings which take high compression loads shall not be greater than the facing thicknesses over 3 in.

Tolerance on overall thickness for press bonded panels is ± 0.010 inch.

The following *NOMINAL* allowances are made for glue line thicknesses in determining dimensions:

1. No allowance for facing to honeycomb core.
2. 0.003 in. for bond between facing and wood.
3. 0.005 in. for bond between facing and doublers or metal inserts.
4. 0.005 in. for each glue line between doublers and metal and phenolic inserts.
5. 0.005 in. for each glue line between adjacent doublers.

Process Control of Assemblies

In addition to incoming quality control on core materials and facing sheets, careful process control, inspection, and testing of the cares, facings, and adhesives are necessary before and after final assembly. Complete details and the procedures followed at Martin are too extensive to be included in the article, but major steps in control are listed in Table IV. Since a good non-destructive inspection test of bonded panels is still lacking, thorough process control becomes highly necessary and is strongly recommended.

Repair of damaged area

When a heavy impact or other unusual service condition causes damage to a honeycomb structure, the damaged area can be repaired. The technique, developed by Martin Engineers and shown in Fig 7 consists briefly of cutting out the damaged facing and core, cleaning and applying adhesive to the facing sheets, and bonding in a ring insert plus core and patch plates by the application of heat and pressure.

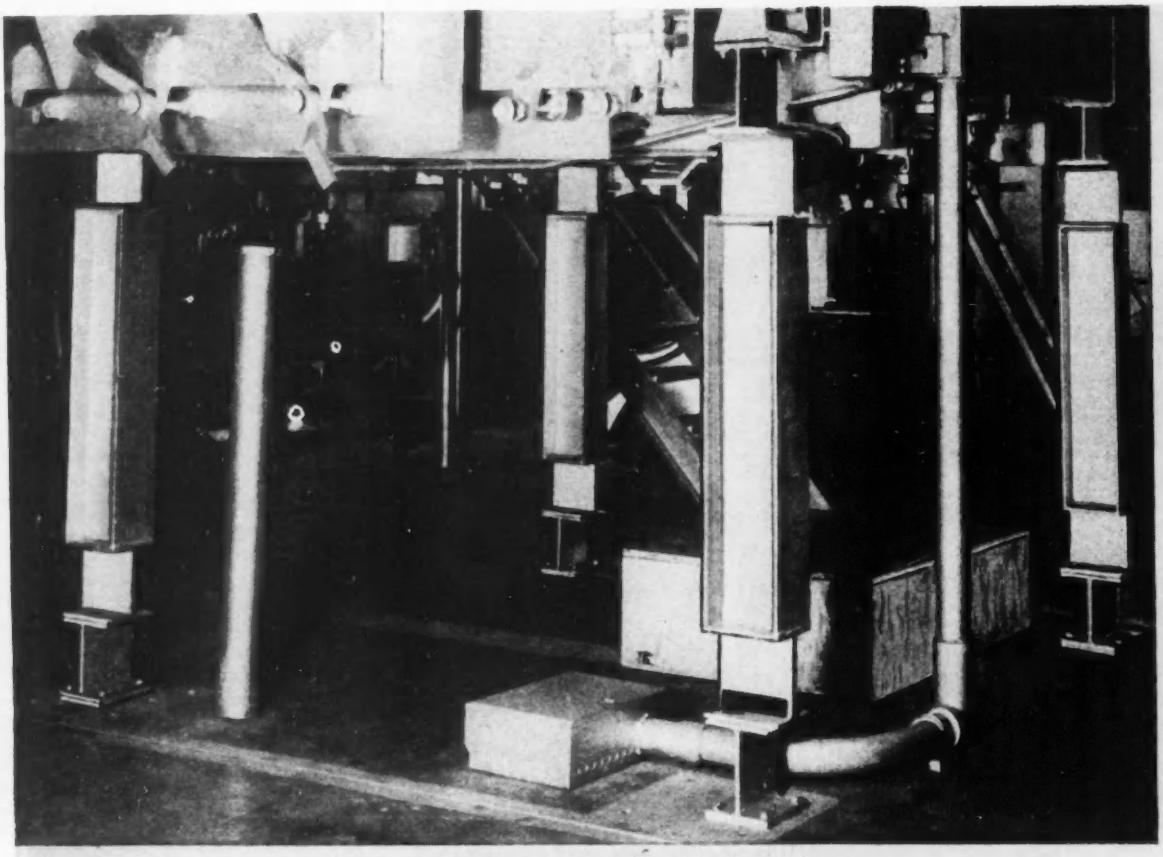


Fig. 1—Constructed from sections of H-beams, this flexure pivot support provides lateral and axial freedom for a portion of a wind tunnel structure. Structure is movable and provides for motion resulting from thermal expansion of tunnel.

Flexure Pivots—Design

Frictionless joints for force measuring systems and structures in which rotational freedom through a small displacement is required. Moment, slope and deflection formulas for determining dimensions of pivots loaded in tension and in compression, with a lateral restraining force and in neutral stability.

ARTHUR G. THORP, II
Supervising Engineer,
Aviation Gas Turbine Division
Westinghouse Electric Corporation

WHERE small angular motions are required, flexure pivots provide a simple and durable method of hinging structural parts together. In such pivots, deflection or rotation occurs as the result of elastic deformation of a beam.

For many years, flexure pivots have been employed in force measuring equipment, Ref. 1, instead of knife edge pivots and ball bearings. As applied in various types of balance systems, flexure pivots are almost frictionless joints capable of carrying loads both in tension or compression. They are not subject to wear, nor do they require lubrication.

One interesting application of flexure pivot design is shown in Fig. 1. In this arrangement, the pivots support a portion of a wind tunnel structure that must be movable for assembly purposes as well as to provide for motion resulting from thermal expansion of the tunnel.

An arrangement that permits a structure to move freely in one direction is shown schematically in Fig. 2. In this design, the pivots are loaded in compression. The upper member is free to move in the horizontal direction through a limited distance dependent upon stress conditions in the pivots. To hold the structure in the deflected position, a transverse force $2Q$ is required. The magnitude and direction of the force $2Q$ depends upon the load $2P$ and the stiffness of the flexure pivots under column loading.

When the pivots are relatively flexible, the restraining force $2Q$ is in the direction indicated in Fig. 2.

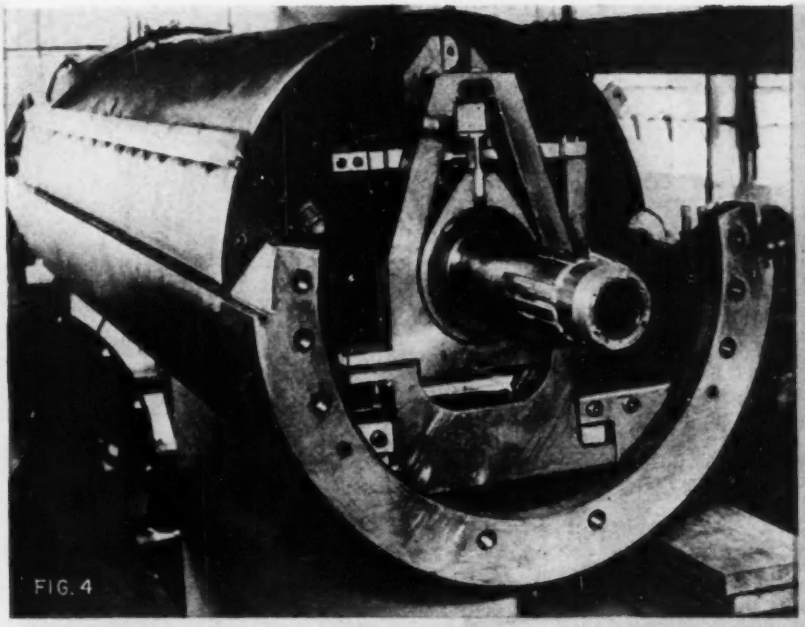


Fig. 2—Support in which pivots and stiff members are loaded axially in compression. Lateral force holds structure in deflected position.

Fig. 3—Suspension in which flexure pivots are loaded axially in tension and the stiff members in compression. Lateral force holds structure in the deflected position.

Fig. 4—Propeller dynamometer suspended on flexure pivots designed for neutral stability. The seven ton floating assembly can be moved in the axial direction by a force equivalent to the weight of a small coin.

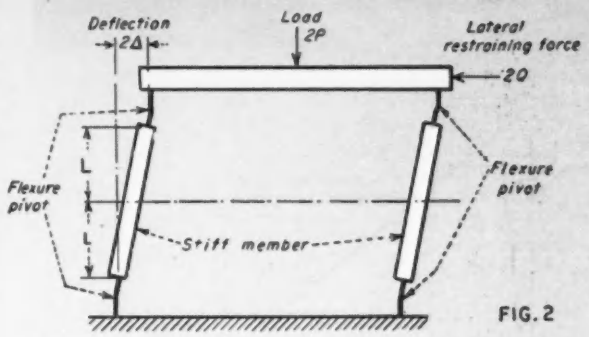


FIG. 2

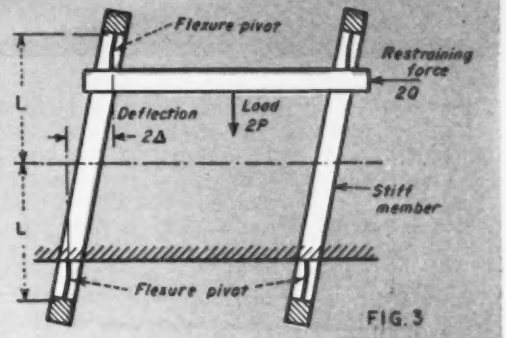


FIG. 3

Formulas and Charts

When the pivots are relatively stiff, this force is opposite to the direction shown. With proper design of the pivots, this lateral force may be made to vanish; thus creating a condition of neutral stability or zero restoring force. This condition, however, can be achieved only under a constant vertical force, which may not always be present in practice.

The achievement of zero restoring force is particularly useful in force measuring equipment where it is desirable to avoid spring forces that would necessitate calibration, and where it is desired to mount a heavy structure that must be moved through a small distance by hand.

Also with zero restoring force, the differential expansion between the structure and the foundation does not require the addition of an external force to hold the internal structural forces in equilibrium.

A suspension in which flexure pivots act in tension rather than compression is shown in Fig. 3. This suspension also may be designed to have zero restoring force or neutral stability under a constant vertical force. Since the pivots are in tension, they do not buckle as pivots loaded in compression may under loads exceeding the design condition.

The general configuration of the arrangement shown in Fig. 3 sometimes lends itself to space requirements that cannot be satisfied by the configuration of Fig. 2. In Fig. 4 is shown one end of a large propeller dynamometer that incorporates the tension type of suspension to provide axial freedom for the measurement of propeller thrust forces.

Where the variation in vertical loading is large and it is desirable to approach as nearly as possible the condition of neutral stability, the arrangement shown in Fig. 5 may be used. With flexure pivots of negligible spring force and for small deflections, the restoring tendency of the upper member will balance the overturning tendency of the lower member, and the structure will move in a plane.

The configurations shown in Figs. 2 and 3 are adapted to the support of large heavy structures and machinery. By providing "universal" flexure pivots, the structure can be made

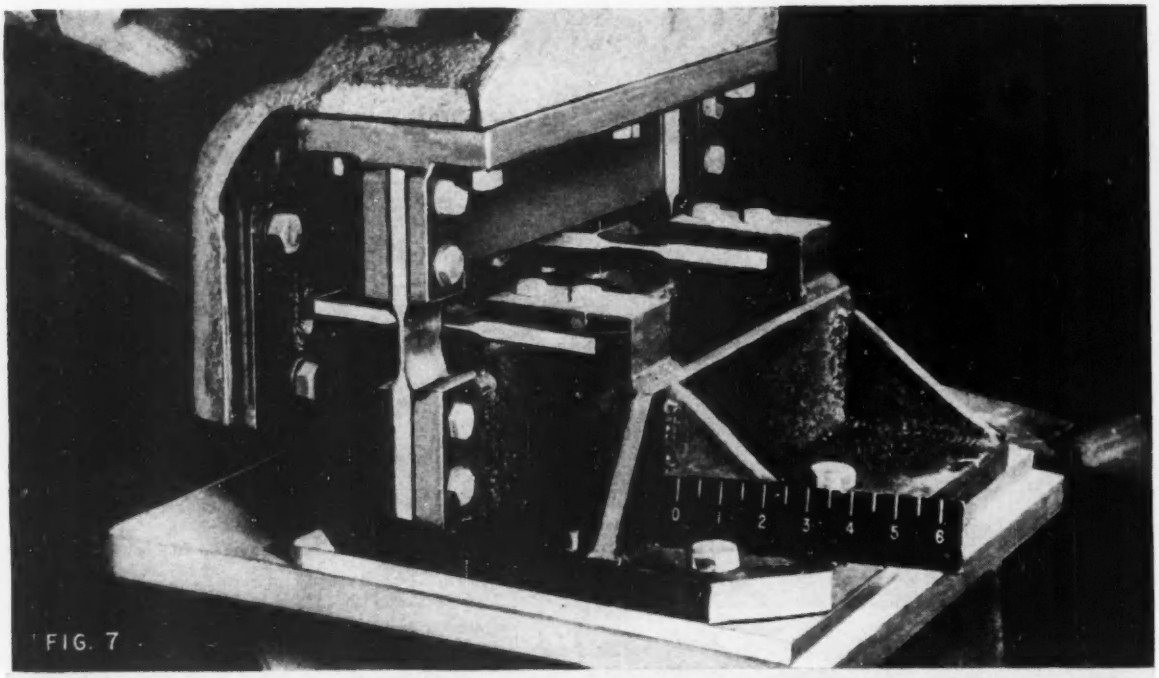


FIG. 7

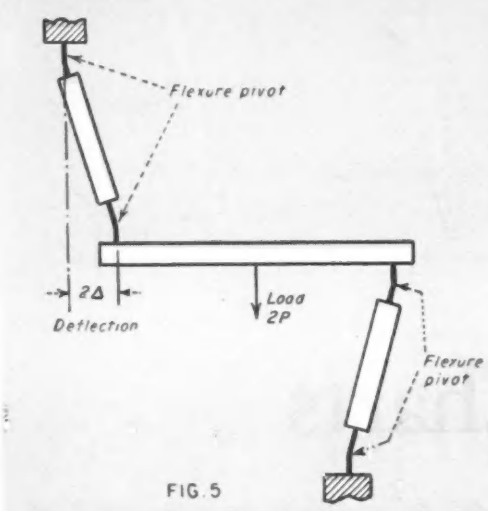


FIG. 5

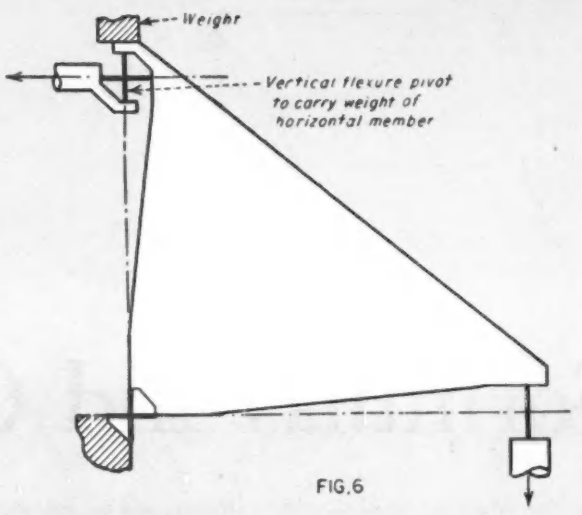


FIG. 6

free to move in any direction in a plane. The universal flexure pivot construction shown in Fig. 1 is simple and inexpensive to fabricate. Other universal arrangements may be employed where it is necessary to limit rotation to acting about a point. Where the loading is light, a rod or wire may be substituted for the plates to provide the universal feature.

The manner in which flexure pivots can be used in the design of balances and control linkages to transmit a force through a bell crank are shown in Figs. 6 and 7. The pivot fastened to the foundation consists of two sets of plates; one for transmitting the vertical component of force and the other for transmitting the horizontal component.

Where small spring forces may be detrimental to proper performance, as in very sensitive balance systems, a weight may be attached to the top of the bell crank to act as an inverted pendulum that counterbalances the spring restoring forces of the flexure pivots.

Another but less common arrangement is shown in Fig. 8. This type of flexure pivot construction may be dictated by space requirements or those imposed by a movable wall, as in a duct for example. The center of rotation of this pivot lies outside of the upper boundary of the structure.

"Cross spring" pivots have been used to advantage in instrument applications, Ref. 2, and wind tunnel balances, Ref. 1, where their advantages are recognized. Less attention has been given, however, to the possibilities of flexure pivots in control linkages. In such applications, it would appear that the ability to transmit

forces in both directions, the lack of need for lubrication, and the general dependability afforded by flexure pivots would be of advantage.

In the following analysis, equations, and tables the symbols used are:

C_n = moment constants
E = modulus of elasticity, psi
I = principal moment of inertia of flexure pivot cross section with respect to axis of bending, in.^{4}
k = $\sqrt{P/EI}$, in.$^{-1}$
l = length of flexure pivot, in.
L = length of stiff member, in.
M = bending moment, in. lb
P = axial force, tension or compression, lb
Q = lateral force, lb
R = distance locating center of rotation of flexure pivot, in.
x = distance along longitudinal axis, in.
y = distance along transverse axis, in.
θ = angle of rotation of stiff member, radians
Δ = deflection at end of stiff member, in.
μ = Poisson's ratio
σ = tensile or compressive stress in pivot, psi
A = cross sectional area of flexure pivot, in.^{2}
Z = section modulus of flexure pivot, in.^{3}

Flexure Pivot Analysis

For small deflections, the analysis of the flexure pivot is the same as that for simple beam-columns as covered by textbooks in advanced strength of materials, Ref. 3. The assumptions made are: Deflections are small so that the equations are linear; and the stiff member connected to the flexure pivot has infinite bending stiffness, thus all bending is required to take place in the flexure pivot.

Where axial forces are imposed on the flexure pivot, the maximum stress σ_{max} in the flexure pivot is the algebraic sum of the average tensile or compressive stress P/A imposed by the axial force and the maximum bending stress M_{max}/Z, or

$$\sigma_{max} = (P/A) + (M_{max}/Z)$$

In design studies, it is important that the stress be checked at the point of maximum moment. Since a flexure pivot acting in compression can buckle as a column if the loads are high enough, the designer should be careful to allow an ample margin of safety.

If the flexure pivot is to be subject to variable bending, it is important that the fatigue strength of the material be taken into account. The Goodman diagram; Soderberg diagram, Ref. 3, p. 488; or similar method should be used to account for the effect of the steady stress upon the fatigue limit. Consideration should also be given to the effect of stress concentration at the ends of the flexure pivot with the provision that ample fillets are to be employed.

Fillets at the ends of flexure pivots alter the effective length l somewhat. For fillet radii approximately equal to the thickness of the flexure pivot, a good rule-of-thumb is to consider the effective length to be the distance between fillet centers plus the fillet radius at one end.

For simplicity, it is generally preferable to use identical flexure pivots at each end of the stiff member, thus making L equal half the length of the stiff member.

Formulas and equations are given in the tabulation on pages 196 and 197 for the solution of the cases most commonly met in practice. To simplify numerical work and to aid in visualizing the effects of the different variables, the curves shown in Figs. 9 to 17 have been constructed to cover a range sufficient for most problems. The design formulas given can be used to obtain increased accuracy or for problems beyond the range of the curves.

Note that in the formulas in which the coefficient k appears that k varies as the square root of P, therefore, these formulas are not linear with respect to the axial force P. This nonlinear relation is typical for all beam column problems and complicates the analysis when the axial load is variable, in which event care must be exercised to make sure that the most severe condition is determined.

The most common form of flexure pivot is a plate of rectangular cross section. When the plate width is greater than 3 times the plate length, the flexural rigidity relation

$$E/(1 - \mu^2)$$

should be used instead of E. For intermediate width to length ratios, if additional accuracy of calculation is necessary, reference can be made to literature, Ref. 4, covering the anticlastic curvature of beams and plates.

The development of the design formulas for Cases 1, 2, 3, 4, 7 and 8 are for a single flexure pivot only, but may be applied to the configurations shown in Figs. 2, 3, and 5 by determining the length L to the point of zero moment in the stiff member. Note that if the two flexure pivots at each end of the stiff connecting member, Figs. 2, 3, and 5, are equal in stiffness and length, there will be no bending moment at the mid-point of the stiff member.

In deriving each equation for end moment M_o and transverse force Q for Cases 1, 2, 3, 4, 7 and 8, the slope at the end of the flexure pivot joining the stiff member was equated to the end deflections Δ minus the deflection y_l at the end of the flexure pivot divided by the length L of the stiff member.

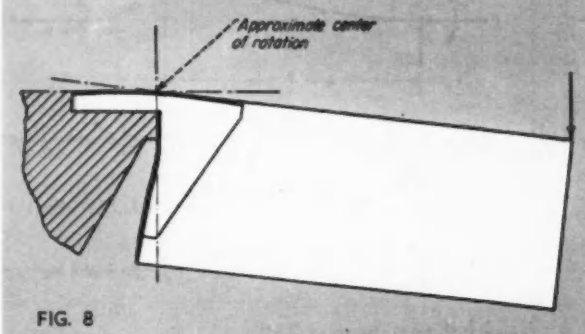


FIG. 8

Fig. 5—The restoring tendency of the upper pivot balances the overturning tendency of the lower member and the structure moves in a plane.

Fig. 6—Flexure pivot arrangement for transmitting force through a bell crank. One pivot plate transmits the vertical component of force and the other plate transmits the horizontal component.

Fig. 7—Flexure pivot fulcrum for carrying both the vertical and the horizontal components of load.

Fig. 8—Type of flexure pivot construction that may be dictated by space requirements or those imposed by a movable wall.

CASE 1—SINGLE FLEXURE PIVOT AND STIFF MEMBER BOTH IN AXIAL TENSION WITH LATERAL RESTRAINING FORCE. Configuration similar to that of the upper pivot shown in Fig. 5 but with a lateral restraining force. When designing pivots of this type, the axial force P, the deflection Δ, and the lengths l and L are generally the prescribed conditions. It is necessary, therefore, to design the flexure pivot to stay within safe stress limits at the point of maximum moment, which in this case is the end moment M_o. The curves in Fig. 9 for C_1 give values of $M_o/P\Delta$ for this case as a function of the variables k, l and L.

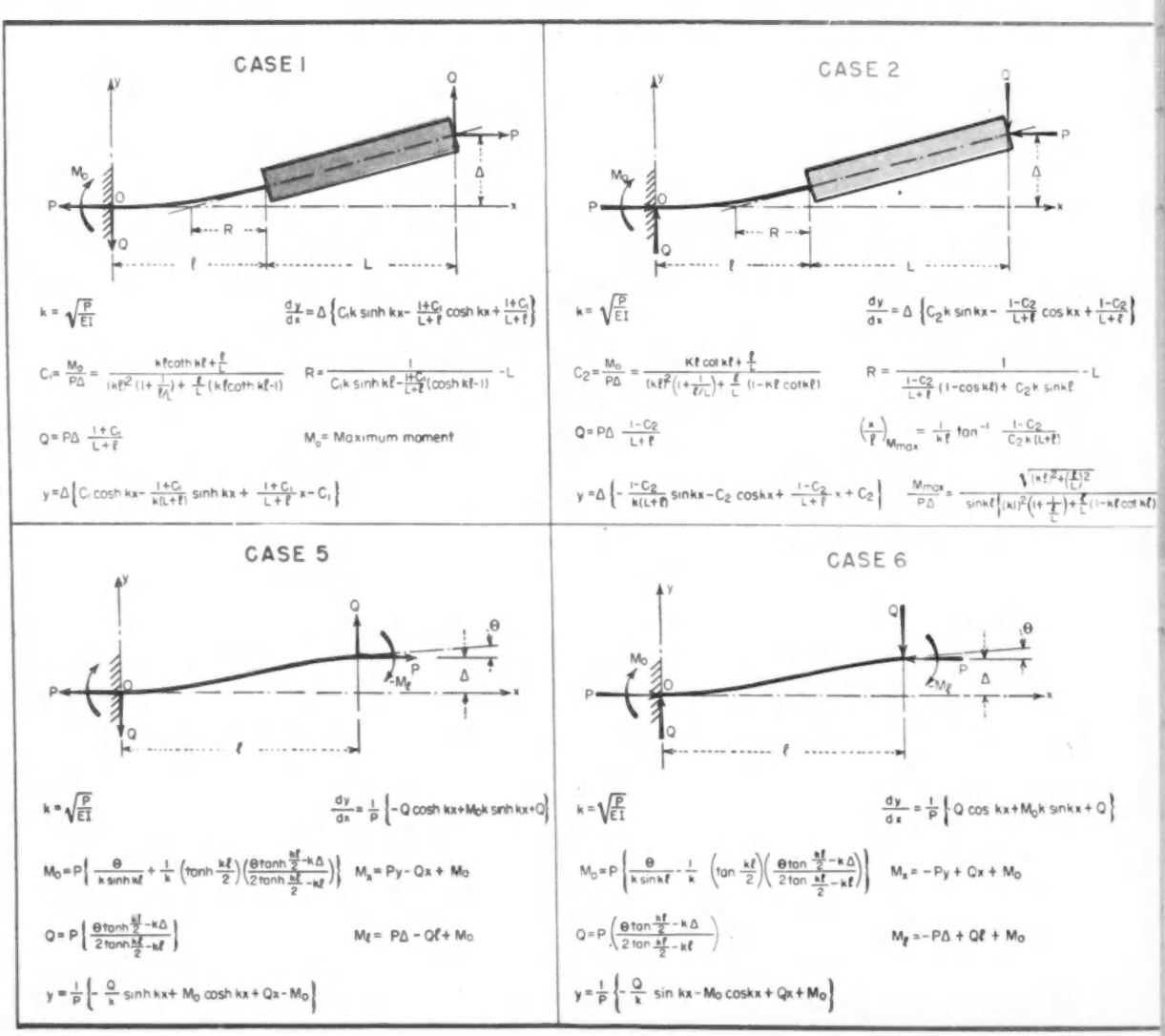
CASE 2—SINGLE FLEXURE PIVOT AND STIFF MEMBER BOTH IN AXIAL COMPRESSION WITH LATERAL RESTRAINING FORCE. Configuration similar to that shown in Fig. 2. When designing pivots of this type, the axial force P, the deflection Δ, and the lengths l and L are generally the prescribed conditions. In this case, the point of maximum moment lies at the distance x from origin as defined by equation given for $(x/l)M_{max}$ below.

The curves in Fig. 10 for C_2 give values of $M_o/P\Delta$ for this case as a function of the variables k, l and L.

The value of the coefficient $C_{2\ max}$ $(M_{max}/P\Delta)$, is given in Fig. 11 as a function of k, l and L, to facilitate obtaining the value of the maximum bending moment M_{max}. Note that for values of kl exceeding approximately 2.2, the maximum bending moment rises rapidly with increasing kl and approaches infinity at values of kl slightly over π. Since k is proportional to the square root of P, a small increase in the axial load will cause large additional bending moments at values of kl exceeding 2.2 and may lead to failure.

From the curves of Fig. 12, the relation between l/L and kl that will provide equal moments at each end of the flexure pivot. This criterion for design should enable the designer to approach a design of minimum weight since the level of bending stress will be nearly constant throughout the length of the flexure pivot.

The curve of Fig. 13 indicates the relation between l/L and kl when the end moment for this case becomes zero. At values of kl above the curve, the end moment reverses becoming negative, thus the flexure pivot will have a point of reverse curvature. It is good practice to avoid values of kl that will cause the end moment to be negative since the assembly acquires considerably more flexibility and has less resistance to incidental transverse forces.



CASE 3—SINGLE FLEXURE PIVOT WITH ZERO AXIAL FORCE AND WITH LATERAL RESTRAINING FORCE. Configuration similar to that shown in Figs. 1 and 3 but where the axial force in the flexure pivot is zero.

CASE 4—SINGLE FLEXURE PIVOT IN TENSION, STIFF MEMBER IN COMPRESSION, WITH LATERAL RESTRAINING FORCE. Configuration similar to that shown in Fig. 3. From the curves shown in Fig. 14 for the coefficient C_4, the value of the end moment for this case can be obtained. Note that below dashed line, values of C_4 also determine maximum bending moment in the flexure pivot; but for values above this line, the maximum moment occurs at the other end. Fig. 15 is constructed for convenience in obtaining the maximum moment in the flexure pivot for region above dashed line of Fig. 14.

The curves in Fig. 12 give the relation between l/L and kl that will provide equal moments at each end of the flexure pivot.

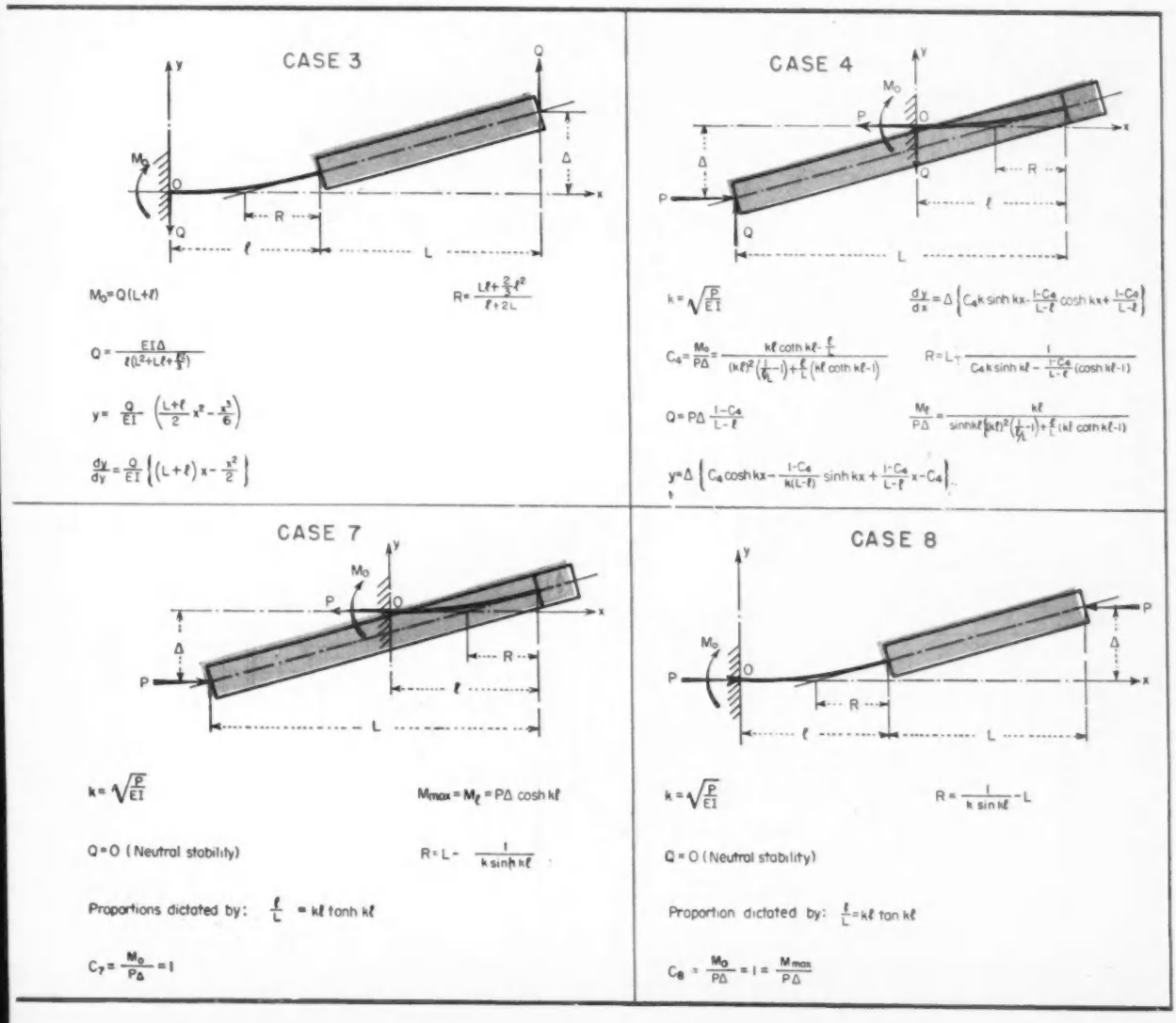
CASES 5 and 6—FLEXURE PIVOT WITHOUT STIFF MEMBER. Configuration similar to that shown in Fig. 8.

CASE 7—SINGLE FLEXURE PIVOT IN TENSION, STIFF MEMBER IN COMPRESSION, WITH NO LATERAL RESTRAINING FORCE. Configuration similar to that shown in Fig. 3 as designed for neutral stability and in Fig. 4. The curve in Fig. 16 for this case gives the relations between k, l and L that provide neutral stability. Note that $M_o/P\Delta$ equals unity is the necessary condition for zero lateral force. Reference should be made to Fig. 15 to obtain the maximum moment.

The curve in Fig. 17 gives the variation in centers of rotation for various values of kl for this case. Note that as k increases the center of rotation moves away from the point of fixity.

CASE 8—SINGLE FLEXURE PIVOT AND STIFF MEMBER BOTH IN COMPRESSION, WITH NO LATERAL RESTRAINING FORCE. Configuration similar to that shown in Fig. 2 as designed for neutral stability. The curve in Fig. 16 for this case gives the relations between k, l and L that provide neutral stability. Note that $M_o/P\Delta$ equals unity is the necessary condition for zero lateral force. Reference should be made to Fig. 11 to obtain the maximum moment for this case.

The curve in Fig. 17 gives the variation in centers of rotation for various values of kl for this case. Note that as k increases the center of rotation moves toward the point of fixity.



CASE 3

$M_o = Q(L+l)$

$R = \frac{Ll + \frac{2}{3}l^2}{l+2L}$

$Q = \frac{EI\Delta}{l(l^2+Ll+\frac{L^2}{3})}$

$y = \frac{Q}{EI}\left(\frac{L+l}{2}x^2 - \frac{x^3}{6}\right)$

$\frac{dy}{dy} = \frac{Q}{EI}\left\{(L+l)x - \frac{x^2}{2}\right\}$

CASE 4

$k = \sqrt{\frac{P}{EI}}$

$\frac{dy}{dx} = \Delta\left\{C_4 k \sinh kx - \frac{1-C_4}{L-l}\cosh kx + \frac{1-C_4}{L-l}\right\}$

$C_4 = \frac{M_o}{P\Delta} = \frac{kl\coth kl - \frac{l}{L}}{(kl)^2\left(\frac{1}{3L}-\frac{1}{L}\right)+\frac{l}{L}(kl\coth kl-1)}$

$R = L_T - \frac{1}{C_4 k \sinh kl - \frac{1-C_4}{L-l}(\cosh kl - 1)}$

$Q = P\Delta\frac{1-C_4}{L-l}$

$\frac{M_l}{P\Delta} = \frac{kl}{\sinh kl\left\{(kl)^2\left(\frac{1}{3L}-\frac{1}{L}\right)+\frac{l}{L}(kl\coth kl-1)\right.}$

$y = \Delta\left\{C_4\cosh kx - \frac{1-C_4}{k(L-l)}\sinh kx + \frac{1-C_4}{L-l}x - C_4\right\}$

CASE 7

$k = \sqrt{\frac{P}{EI}}$

$M_{max} = M_l = P\Delta\cosh kl$

$Q = 0$ (Neutral stability)

$R = L - \frac{1}{k\sinh kl}$

Proportions dictated by: $\frac{l}{L} = kl\tanh kl$

$C_7 = \frac{M_o}{P\Delta} = 1$

CASE 8

$k = \sqrt{\frac{P}{EI}}$

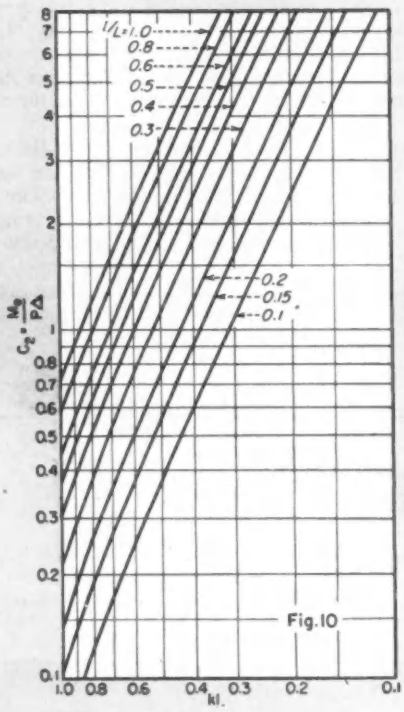
$R = \frac{1}{k\sin kl} - L$

$Q = 0$ (Neutral stability)

Proportion dictated by: $\frac{l}{L} = kl\tan kl$

$C_8 = \frac{M_o}{P\Delta} = 1 = \frac{M_{max}}{P\Delta}$

Fig. 9—Chart for obtaining value of end moment M_o, Case 1, when pivot and stiff member are both in axial tension and a lateral restraining force is provided.



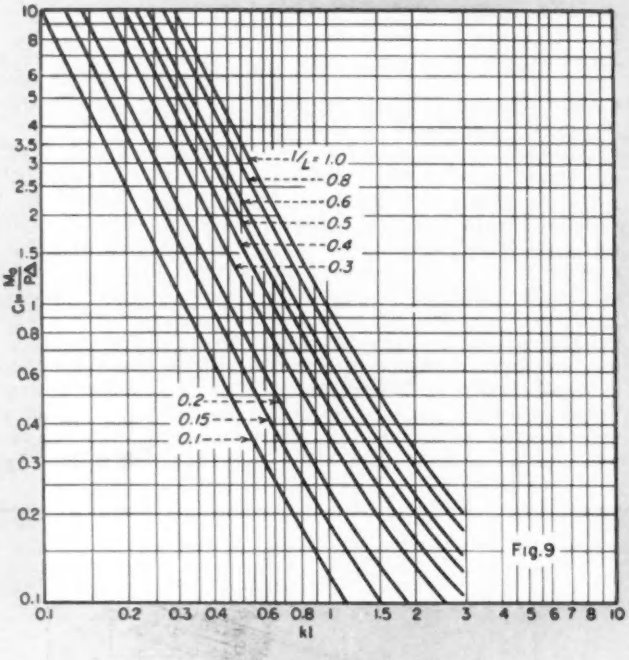
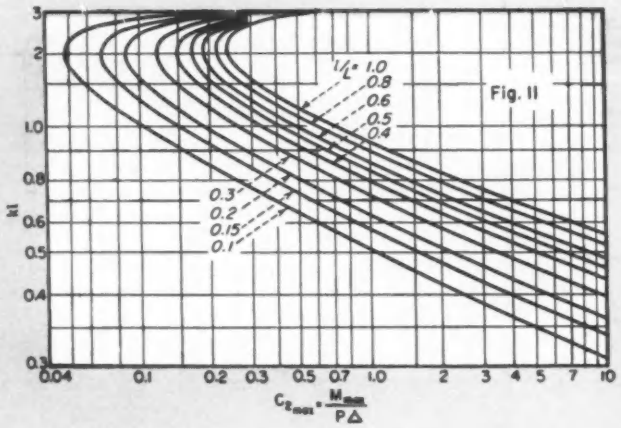


Fig. 10—Chart for obtaining value of end moment M_o, Case 2, when pivot and stiff member are both in axial compression and a lateral restraining force is provided.

Fig. 11—Chart for obtaining value of maximum moment, Case 2, when pivot and stiff member are both in axial compression and a lateral restraining force is provided.



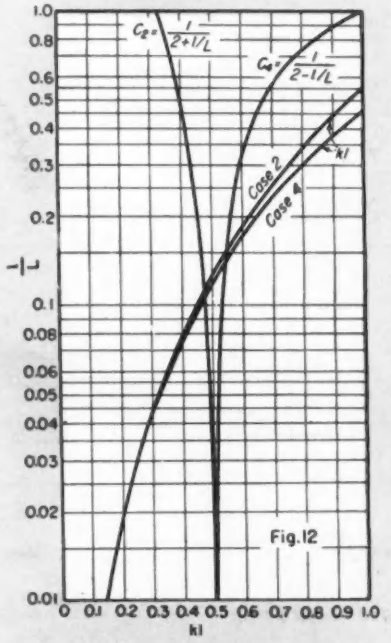


Fig. 12—Relations for Cases 2 and 4 for M_o equal to M_1, or that provide equal moments at each end of the flexure pivot.

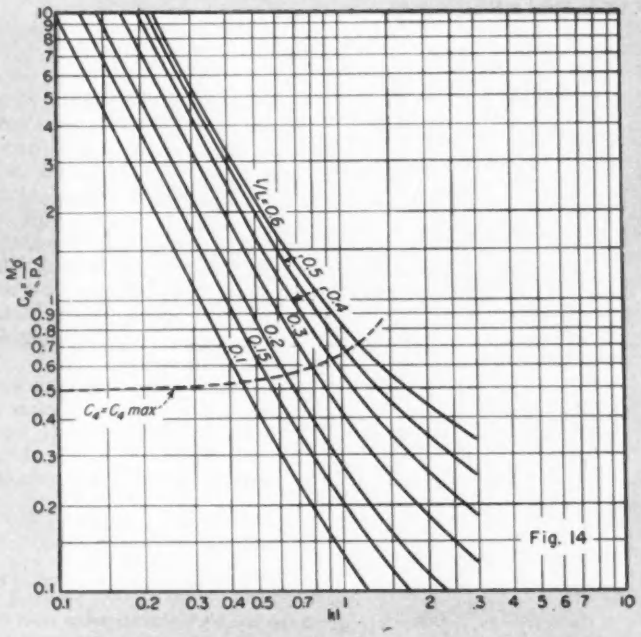


Fig. 14—Chart for obtaining value of end moment, Case 4. Values below the dashed line also determine the maximum bending moment in the flexure pivot. For values above the dashed line, the maximum moment occurs at the other end, see Fig. 15.

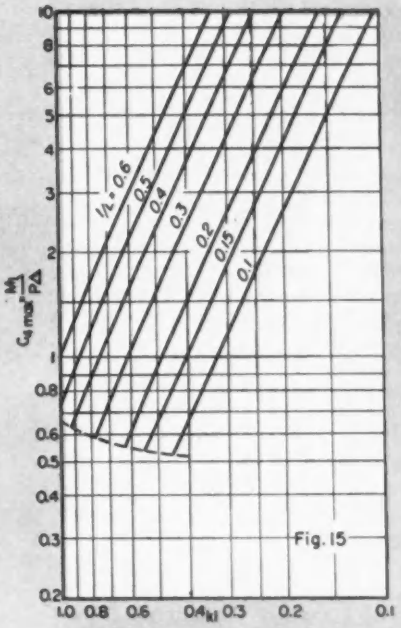


Fig. 15—Chart for obtaining the maximum moment, Case 4, when at the deflected end of flexure pivot.

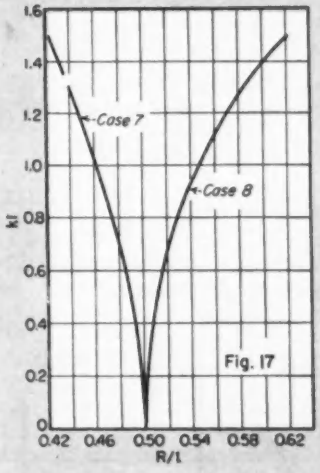
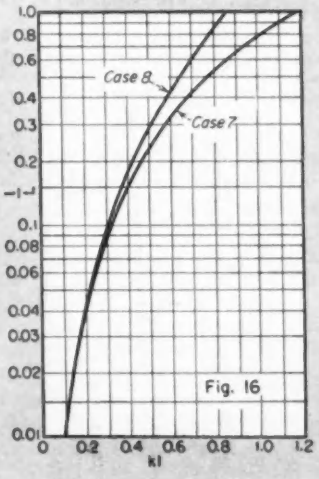


Fig. 16—Design relations, Cases 7 and 8, that provide neutral stability or zero lateral force.

Fig. 17—Chart for obtaining center of rotation, Cases 7 and 8, for various design conditions.



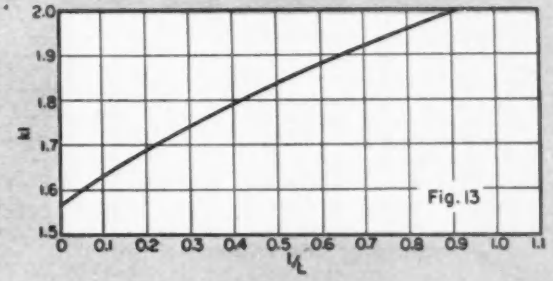


Fig. 13—Design conditions for Case 2 to produce a zero end moment in the pivot.

Design Procedure

EXAMPLE I. A dynamometer is to be designed for measuring jet engine thrust utilizing a bedplate supported at the ends by eight flexure pivots as shown in Fig. 18. Vertical space available for the pivot support is 28 in. Combined weight of bedplate, engine and mounting brackets is 19,500 lb, which is distributed equally on the four pivot supports.

Thrust is to be measured at one end of the bedplate by a weighing cell that operates on a null principle limiting axial deflection to a few thousandths of an inch.

With prolonged engine operation, the bedplate is heated to 110 F, while the temperature of the foundation remains at approximately 60F; thus the differential thermal expansion is

$$140 \times (110\text{-}60) \times 6.5 \times 10^{-6} = 0.0455 \text{ in.}$$

Manufacturing and erection tolerances require an additional allowance of 0.06 in. relative axial deflection of the flexure pivots.

As a result of the differential thermal expansion between the bedplate and the foundation, spring forces will affect the thrust readings unless the flexure pivots are designed for neutral stability. It is desired to make the flexure pivots 2 in. long.

SOLUTION:

$\Delta = (0.0455 + 0.06)/2 = 0.0527$ in.
$l = 2$ in., $L = 24/2 = 12$ in.,
$l/L = 2/12 = 0.1667$
$P = 19{,}500/4 = 4{,}875$ lb

Assuming that the pivot is relatively wide, the effective modulus of elasticity is

$$E_{eff} = \frac{30 \times 10^6}{1 - \mu^2} = \frac{30 \times 10^6}{1 - 0.09} = 33 \times 10^6$$

From Fig. 16, Case 8;

$$kl = 0.397$$
$$\text{or } k = 0.397/2 = 0.1985$$
$$\text{since } k = \sqrt{P/EI} = 0.1985$$
$$I = \frac{P}{0.1985^2 E_{eff}} = \frac{4{,}875}{0.039 \times 33 \times 10^6} = 3.77 \times 10^{-3}$$

Assuming the flexure pivot to be 6 in. wide; thickness t of the plate is

$$t = \sqrt[3]{12\,I/6} = \sqrt[3]{2 \times 3.77 \times 10^{-3}} = 0.196 \text{ in.}$$

From the table, Case 8; the maximum coefficient C_8 is

$$C_8 = M_{max}/P\Delta = 1$$

or

$$M_{max} = C_8 P \Delta = 1 \times 4{,}875 \times 0.0527 = 257 \text{ in. lb}$$

Maximum total compressive stress is

$$\sigma_{max} = (P/A) + (M_{max}/Z)$$
$$= \frac{4{,}875}{6 \times 0.196} + \frac{257 \times (0.196/2)}{3.77 \times 10^{-3}}$$
$$= 4{,}145 + 6{,}681 = 10{,}826 \text{ psi}$$

Maximum tensile stress is

$$6{,}681 - 4{,}145 = 2536 \text{ psi}$$

EXAMPLE II. To demonstrate the effect of improper flexure pivot thickness upon thrust, assume that in Example I the thickness is changed to 0.25 in., then

$$k = \sqrt{\frac{P}{EI}} = \sqrt{\frac{4{,}875}{33 \times 10^6 \times 6 \times 0.25^3/12}} = 0.1375$$
$$kl = 0.1375 \times 2 = 0.275$$

From Fig. 10 for $kl = 0.275$, and $l/L = 0.1667$

$$C_2 = 2.11$$

From the table, Case 2

$$Q = P\Delta\left(\frac{1 - C_2}{L + l}\right)$$
$$= 4{,}875 \times \frac{0.0455}{2}\left(\frac{1 - 2.11}{12 + 2}\right)$$
$$= -8.78 \text{ lb}$$

Since there are two flexure pivots at the end of the bedplate, total error in thrust as a result of differential thermal expansion between the bedplate and the foundation would be twice 8.78 or 17.56 lb. For a jet engine developing 5,000 lb thrust, this error is only 1/3 of one percent. This error, however, may be excessive where relatively small differences in thrust are desired to be measured during development of the engine.

The use of 0.375 in. thick flexure pivots would result in a thrust error of 100 lb. If the flexure pivots were made thinner than 0.196 in., the thrust error would approach a maximum value of

$$\frac{2\,P\Delta}{L + l} = \frac{2 \times 4{,}875 \times 0.0455}{12 + 2} = 31.7 \text{ lb}$$

ACKNOWLEDGMENT: Most of the examples as well as all the photographs presented in the foregoing discussion are taken from the author's NACA experience. Permission for the use of the material is gratefully acknowledged.

REFERENCES

1. "Flexure Pivots to Replace Knife Edges and Ball Bearings"; F. S. Eastman, Univ. of Washington Engineering, Experiment Station, Bull. No. 86.
2. "An Investigation of the Cross-Spring Pivot"; W. E. Young, ASME Journal of Applied Mechanics, June 1944, pp A-113-120.
3. "Strength of Materials, Part II"; S. Timoshenko, D. Van Nostrand Co., 1940, pp 25-50.
4. "The Anticlastic Curvature of Rectangular Beams and Plates"; D. G. Ashwell, Journal of the Royal Aeronautical Society, Nov. 1950, pp 708-715.

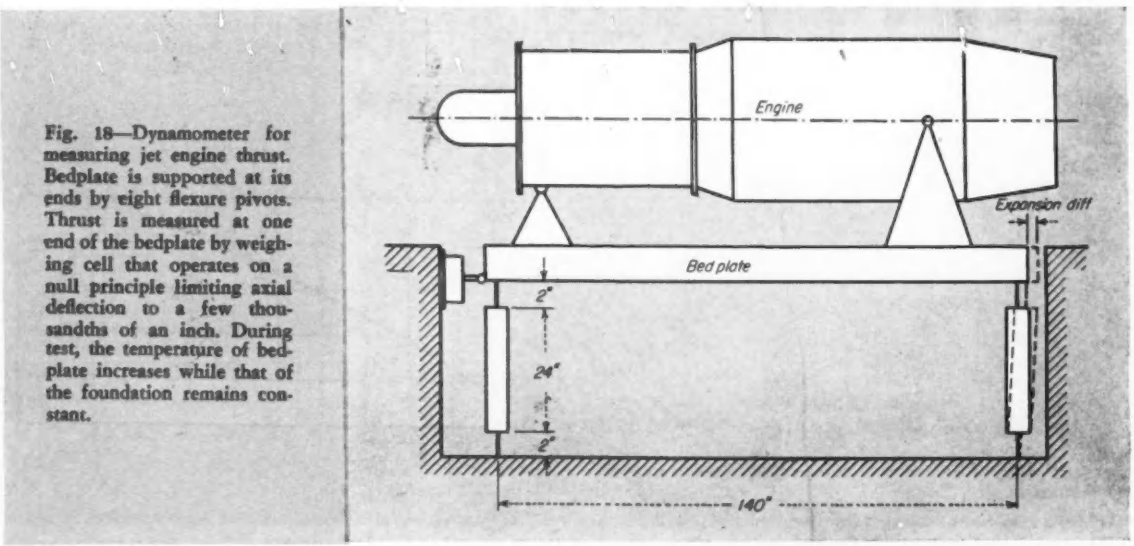
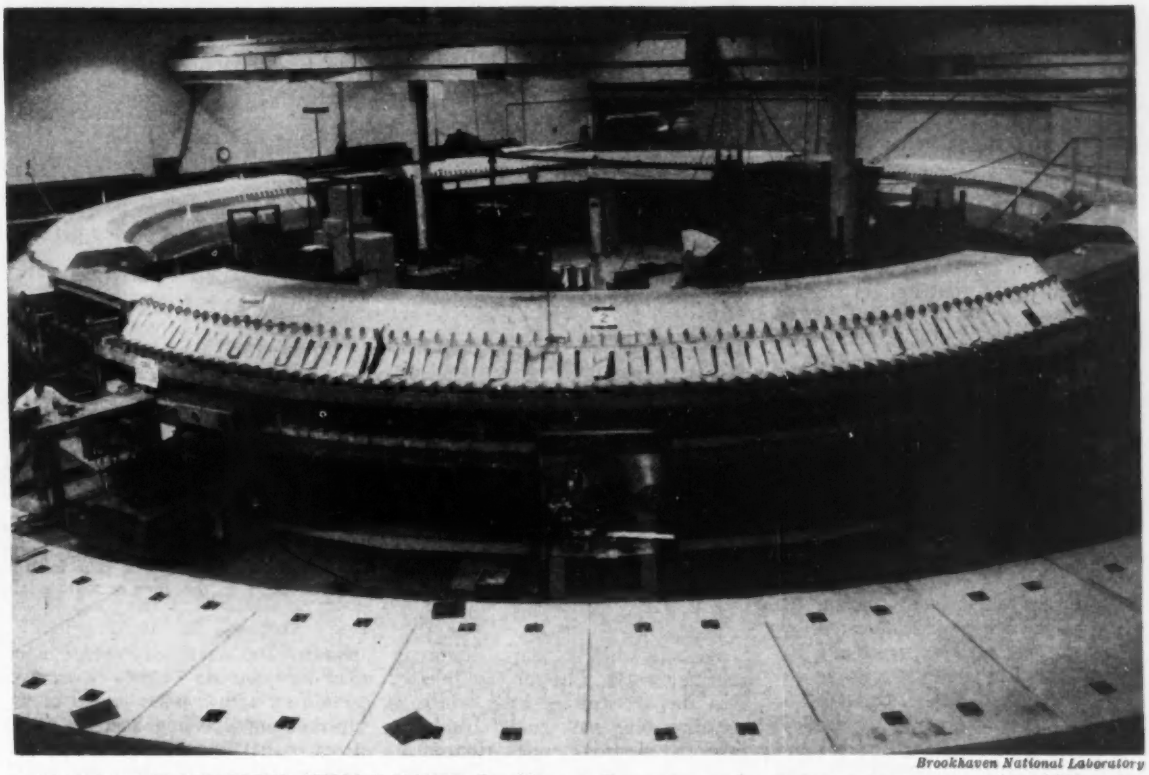


Fig. 18—Dynamometer for measuring jet engine thrust. Bedplate is supported at its ends by eight flexure pivots. Thrust is measured at one end of the bedplate by weighing cell that operates on a null principle limiting axial deflection to a few thousandths of an inch. During test, the temperature of bedplate increases while that of the foundation remains constant.

TECHNICAL NEWS



Brookhaven National Laboratory

WORLD'S MOST POWERFUL ATOM SMASHER, Brookhaven's Cosmotron, accelerates protons to an energy of 3.2 billion electron volts. Operating on the synchrotron principle the machine weighs over 2,200 tons. Ring, in center of cut, is the magnet; three units in front of this are vacuum pumps that evacuate the donut in which the protons travel; blocks in foreground are shielding.

Giant Atom Smashers Ready to Probe the Nucleus

RESEARCH EQUIPMENT has come a long way from the time when a scientist needed only sealing wax, string and a few mechanical gadgets for his experiments. This transition was again brought home by two recent events:

- At Brookhaven National Laboratory, scientists dedicated the new 2,200 ton, 3.2 billion electron volt Cosmotron, biggest and most powerful atom smasher in the world.
- At Stanford University, microwave specialists announced that their multi-million dollar, billion volt straight-line atom smasher was almost ready for nuclear experimentation.

These developments represent the culmination of two different theories in high energy machinery design. Operating on the so-called synchrotron principle, Brookhaven's machine has evolved from the cyclotron, first successfully used in 1933. Stanford's linear accelerator is a new approach to the problem, not even mentioned in physics text books five years ago.

► **Circular accelerators.** When scientists started thinking of billion volt atom smashers, most immediately considered a circular type of accelerator because physicists had fifteen years of successful cyclotron experience.

In this machine heavier particles, like alphas or protons, spiral outward as they increase in energy because of a magnetic field perpendicular to the plane of their orbit. An alternating rf electrostatic field timed with these revolutions, accelerates the particle.

There are two limitations to this machine: 1) to increase the power output, it is necessary to design an entirely new machine scaled upwards in size many times more than the power increase; and 2) it is difficult to compensate for relativistic mass changes in the particle as it approaches the speed of light making the machine incapable of accelerating electrons.

► **For relativistic changes.** Therefore, scientists developed the synchro-cyclotron and the betatron (to accelerate electrons). In the former, the frequency of the electrostatic field was varied to compensate for relativistic changes. As the particle speeds up and increases in mass, the rf is decreased so it remains in tune with the particle. In the latter, the magnetic field is varied in such a manner that the machine may be considered a large transformer in which the secondary coil is a stream of electrons travelling in a vacuum tube instead of a coil of wire.

These machines enabled researchers to reach 500 million electron volts, but further increases meant machines of an impractical size. This stimulated development of the synchrotron, a device that starts on the principle of the betatron; uses the varying magnetic field to accelerate the particles to a certain voltage; and then employs a resonant rf cavity to further accelerate the particles. Scientists realized that to increase the power of such a machine they would merely have to in-

crease the input to the cavity instead of adding tons of iron.

▶ **Brookhaven's Cosmotron.** This principle applied to the acceleration of protons, the nucleus of hydrogen, is the heart of Brookhaven's cosmotron. The magnets for initial acceleration and for holding the particles in a fixed circular orbit are ring shaped, with an inside diameter of 60 ft. Because of the open center, these magnets represent a saving of thousands of tons of iron.

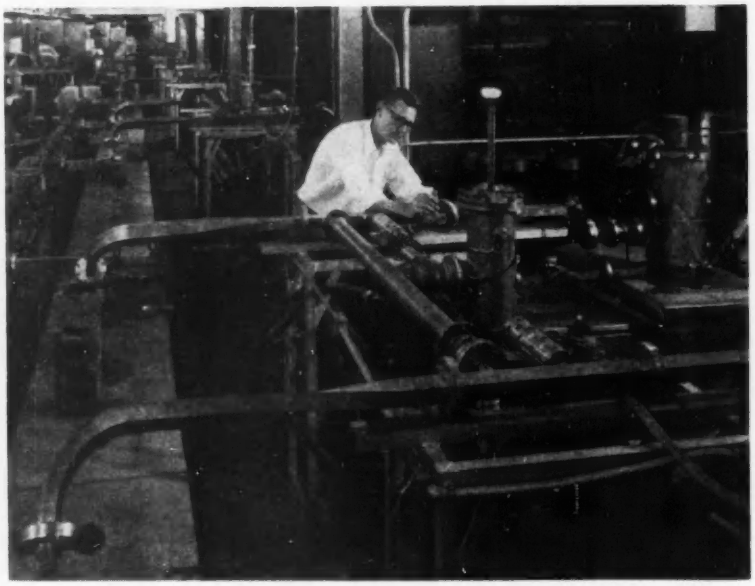
Injected into the machine with an initial energy of four million electron volts by an electro-mechanical generator, the protons travel around the magnet 3 million times before they reach their maximum energy. Each time they pass through the electrostatic field, they pick up an energy boost of about 800 v.

There is no spiraling action of the proton at high energies in the synchrotron because the varying field is synchronized to maintain a fixed orbit.

▶ **Types of experiments.** After the protons reach their maximum energy, they are permitted to strike a target to perform two different types of experiments. In one type, the target is made of the material to be studied. Scientists can make measurements and analyze the effects of bombarding that particular nucleus with these high energy particles. In the second method, the particles hit a target of standard material which then emits cosmic radiations like high energy gamma rays, and mesons. These are studied or used to bombard other materials.

A machine like the cosmotron requires tremendous supporting electrical machinery. Typical examples: a 21,000 kva generator delivers 40 million watts to energize the magnets; 24 giant-size ignitrons serve as rectifiers to supply d-c current to the magnets and as inverters so the major part of the magnetic energy can be returned to the flywheel for storage for the next operation; rf system to supply "kicks" to the rotating proton uses 100 kw, twice the output of the most powerful radio station.

▶ **Stanford's Lineac.** At the Microwave laboratory on the Stanford campus, the second billion volt atom smasher looks more like plumbing than anything else. Most obvious component is the accelerator tube, 220 ft of ten-foot copper pipe sections. Every ten feet there is a 20 million watt klystron, biggest electron tubes ever built, that produces an electromagnetic wave to accelerate the electrons.



BILLION VOLT LINEAC stretches over 300 feet; each ten foot section is a separate 25 million volt linear accelerator. Stanford graduate student is adjusting one of the leads on 20 million watt klystron, most powerful tube ever built. The tube itself is housed in lead at the far right. Accelerator tube is the 3¼ in. dia. pipe at the far left.

Basically this is how a linear accelerator works. Electrons are injected into the accelerating tube which is actually a long wave guide. Inside the tube, the electrons "ride" electromagnetic waves produced by the klystrons. Each ten feet oscillators supply a kick of 25 mev as the electron moves down the straight path.

▶ **High speed, high mass.** When the electron reaches the end of the tube, its speed is 99.9999 percent the velocity of light, and its relativistic mass is 2,000 times its mass at rest.

Along the tube there are six experimental stations, three along one side at the 10 ft, 100 ft, and 130 ft marks, and three at the end. Stations along the tube permit monitoring the electron beam as well as experimentation with lower energy electrons. Those at the end are for high power atom smashing experiments.

There are several big advantages to this type of accelerator. First it requires no tremendous tonnage of magnets. And since each section of the unit is actually a small linear accelerator, power can be increased or decreased by adding or removing ten foot sections. Stanford scientists estimate that the major portion of their expenses went for development studies. They claim they could duplicate the machine for less than one-third of the $2½ million original cost.

Lineac uses a three-phase "y" connected power supply; 100 kva per phase; 4,200 volt phase-to-phase input. The klystrons are 3-cavity type power amplifiers with a pulse length of 1.6 microseconds. While average power from pulsers is only 25 kw, the total peak exceeds one billion watts.

▶ **What are they for?** Scientists have big plans for these two atom smashers. Main reason for building billion volt atom smashers was to supply a source of cosmic rays in the laboratory. Previously it was necessary to make such studies with high altitude balloons, a slow and irregular process.

Prime interest in cosmic rays develops around the elusive meson, a single-charged particle with a mass between that of the proton and the electron. Ever since Japanese scientist Yukawa predicted their existence, physicists have felt that the meson holds the key to some of the mysterious forces in the nucleus.

Physicists feel that once they can manufacture these mysterious particles in the laboratory, in quantity, they will be able to answer many questions about the construction of matter.

In addition, scientists will be able to carry on controlled high energy experiments to duplicate conditions occurring in atomic devices like the atomic power plant and the atom bomb.

By gathering data on nuclear reactions they hope to be able to speed the development of efficient reactors and new useful materials.

Measuring Soil Corrosion Electrically

WHEN IRON OR STEEL is exposed to soil, small corrosion cells form because of local differences in electrical potential developed at the surface of the metal. According to the National Bureau of Standards, the corrosion rate precipitated by these cells can be measured electrically, eliminating the need for visual or weight inspections.

▶ **From Faraday's Law.** NBS based their technique on a well known theoretical expression:

$$i_o = \frac{I_p I_q}{I_p + I_q}$$

where i_o is corrosion current, and I_p and I_q are the currents applied to the cathode and the anode to reduce the corrosion current to zero. NBS's major contribution was the experimental confirmation that weight loss due to corrosion could be determined from this equation.

The big problem is determining the values of I_p and I_q. The Bureau says it can be done by plotting polarization curves, potentials (measured with an electronic interrupter in conjunction with a potentiometric circuit) versus applied current.

As increments of current are applied to the cathode and anode of a corrosion cell, the potential of the cell changes. When these measured potentials are plotted against the applied currents, a change in the slope of the curve marks the point at which the applied currents have reduced local corrosion to zero. This point gives the values of I_p and I_q that are used to evaluate i_o, the corrosion current.

In a series of experiments, NBS scientists measured corrosion weight losses electrically within four percent of actual weighed losses. For the study, the researchers buried weighed specimens of steel in five different kinds of soil, varying from very acid to very alkaline, for two months. Polarization curves were obtained at intervals throughout the exposure period just in case the rate of corrosion changed during the two month period.

▶ **What it means.** The Bureau expects that this new measuring technique will have extensive application in the laboratory and in field installations. They predict it will permit more accurate comparisons of the corrosion properties of material.

Too, it will enable engineers to determine the rate of corrosion of buried materials in soils where ferrous metals corrode at a constant rate year after year, as well as in soils where corrosion may slow down and in time virtually stop. The present technique of weighing objects indicates only the amount of total corrosion without supplying any information as to rates.

Aside from soil corrosion, one significant application may lie in the determination of corrosion rates for metals submersed in acqueous fluids. As yet the Bureau has no data on this phase of the study, but they feel the method should work equally well.

Abrasive Belt Replaces Diamond Wheel Sharpener

USING A COATED ABRASIVE BELT instead of a diamond wheel, a new method of sharpening tungsten carbide tools reduces costs by two-thirds and produces a longer lasting cutting edge. Heart of the new process, developed jointly by Behr-Manning Corporation and Fenlind Engineering Company, is a waterproof, 220-grit, silicon carbide paper belt, driven by a cast iron contact wheel.

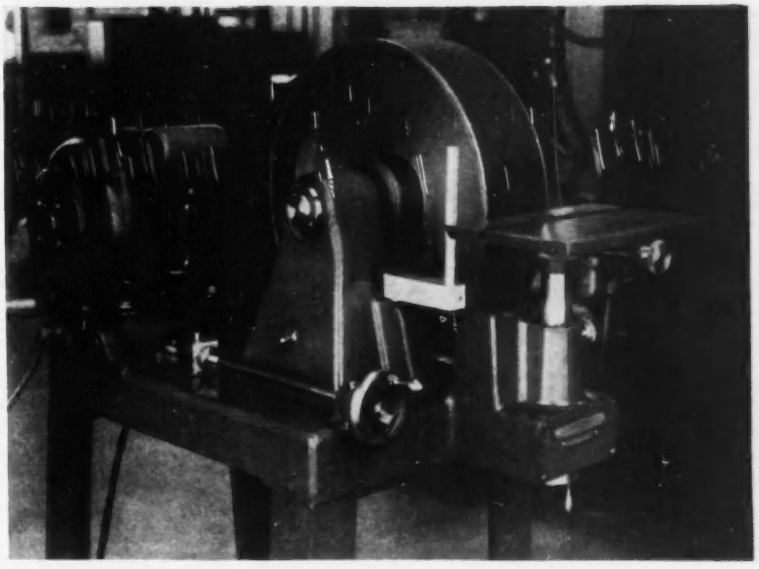
In field tests Behr-Manning engineers found that the average cost of sharpening a carbide tungsten tool ranges between one and three cents per tool with the belt grinder, compared to six to 17 cents per tool with a diamond wheel. Major economy stems from the elimination of two operations—the intermediate grind and finish-honing.

After a silicon carbide wheel rough grinds the clearance angle on the tool, the abrasive belt micro-finishes the relief angle and final cutting surface in one operation. The price of about $485 for the Fenlind Micro-Finisher brings the cost of maintaining tungsten carbide cutting tools down low enough so that most small shops will be able to afford them.

In addition, controlled tests indicate that the new technique almost doubles the life of the cutting tools. On a production line cutting 5665 nickel alloy, the abrasive belt-sharpened tools completed an average of 34 pieces between sharpenings, diamond-honed tools only 12 pieces. Cutting AMS 5060 steel the abrasive belt-sharpened tools finished 202 pieces compared to 102 pieces by diamond wheel-sharpened tools.

Engineers attribute the longer life to the 2-16 micro-inches rms finish produced by the belt technique. Too, the belt does not chip the cutting edge of the tool, a phenomena that requires diamond honing when tools are sharpened by conventional methods.

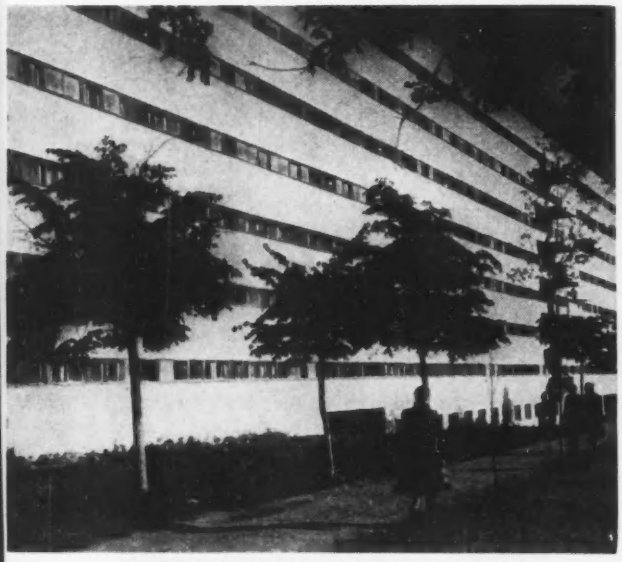
Other machine tools similarly equipped with abrasive belts for economy—a centerless grinder and a conjugate profile grinder.



FENLIND MICRO-FINISHER uses a silicon carbide abrasive belt on a paper backing instead of a diamond wheel to sharpen tungsten carbide cutting tools. Abrasive belts replacing grinding wheels represent a new design trend, part of industry's efforts to reduce production and equipment costs while maintaining quality.

AT THE ELECTRO-MECHANICAL INSTITUTE, MOSCOW, Russians use large lecture rooms to keep pace with growing needs for electrical and mechanical engineers.

AT THE KIROV POLYTECHNICAL INSTITUTE, GEORGIA, students study construction, mining, automotive engineering, and machine design. It has turned out 10,000 graduates in its 30 year history.



AT THE MOSCOW MINING INSTITUTE, students live in this seven story dormitory, indicative of the interest the Russians have in mining and the large number of mining engineers they are training.

AT THE BYELORUSSIAN POLYTECHNICAL INSTITUTE, MINSK, there are 128 faculty members in the Institute's 39 departments. This shows the heating and ventilation laboratory of the 20-year old school that specializes in heat-power engineering.

AT THE MOSCOW INSTITUTE OF RAILWAY ENGINEERS, students use this large library reading room for study purposes. Each school has its own library facilities.

AT THE DNIEPROPETROVSK MINING INSTITUTE, students get first-hand knowledge of a Donbas, Russian automatic coal mining machine. Apparently this school is also a military institute.

Tough Training Backs Russian Engineers

Product Engineering prepared this exclusive article from material supplied by the Russian Ministry of Education. Last October, the magazine queried the Soviet's Washington embassy on the status of Russian engineers. The embassy forwarded the questions to Moscow, and this story is the result.

IN KOREA the quality of captured Russian material has proved that Soviet engineers rank with the best in the world. More than anything else, Russia's intensive engineer training program has brought about this explosive change from an agricultural Soviet Union whose people were barely touched by the Industrial Revolution.

Since they took over Russia, the Communists have been busy revolutionizing education in Eurasia. They've parleyed the handful of universities inherited from the Tsarist regime into 890 institutions of higher learning with an enrollment of 1,400,000.

The Soviets recognized that their country's major deficiency was a lack of industrialization, and the biggest headache was a lack of technical personnel, so they started setting up two kinds of colleges: (1) polytechnical institutes for the study of various engineering fields and sciences, and (2) specialized institutes where students concentrate on critically needed subjects like railroad engineering, machine design, or mining.

▶ **An American Comparison.** Basically, Russian engineering curricula compare with the cooperative education programs at a few American Universities. They combine actual work experience with class room theory. While the Russian student spends about 800 more hours in the classroom than his American counterpart, he studies similar subjects.

In addition, creative design is emphasized to a greater extent by the Soviets. Before a student can specialize, he has to develop a sound understanding of the principles of mechanics and mechanisms.

▶ **Special Inducements.** Rewards for successful completion of these courses are more lucrative than in the U. S. The graduate engineer can expect bonuses in the form of considerably higher pay scales than other workers, bigger food and clothing rations, a position of esteem and respect in the community, other special privileges and deferment from military service. On the other hand, the student who fails to make the grade may end up anywhere in the controlled economy.

Five year programs and the Russians are synonymous, so it's no surprise to find that the usual Russian engineering curriculum spans five years, or longer. Subject material for the first three years is the same at all colleges—basic fundamentals of engineering along with heavy doses of political and social sciences.

It's not until the senior years that a student can specialize along definite lines. Then a student in machine building, for instance, studies quite specific subjects like automatic controls, metal cutting machine tools, or testing and gaging.

▶ **A Typical Course.** In a Soviet curriculum, the academic subjects add up to about 5,000 hr. 2,700 of these are devoted to general engineering subjects like descriptive geometry, drafting, physics, chemistry, mathematics, theoretical mechanics, and strength of materials. In the last two senior years, specialized subjects require, on the average, 1,500 hr. This leaves the politically-conscious Reds almost 800 hr for the study of humanity subjects.

However, classroom study is only one part of the course. Equally important are three other phases: so-called instructional projects, scientific research, and work practice.

The instructional projects can be compared to American term papers, but they are more specific in nature, more detailed and more practical. Each student has to complete three of these during his basic training, regardless of his field of specialization.

▶ **Emphasis on Design.** The Communists don't give their students a chance to develop contempt for mechanical drawing. Each of the basic projects is a design problem that requires five or six blueprints as well as a complete description of the subject. Choice of subject matter is strictly defined: one project must be on machine parts; one on hoisting machines and mechanisms, and the last on theory of machines and mechanisms.

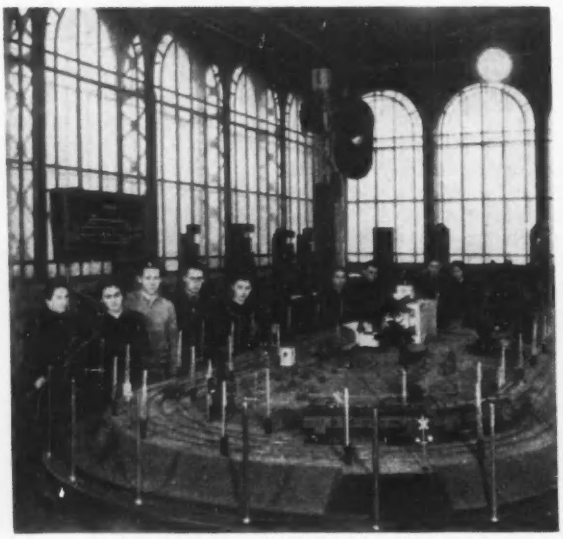
During the period of specialized training, the student completes two or three additional projects in his own field. In conjunction with these projects, the students take part in scientific research. The state sets up circles of research at the various colleges and professors direct under-gra-

CHEMISTRY is also a first year requirement. This is a chemistry laboratory at the Azerbajian Industrial Institute.

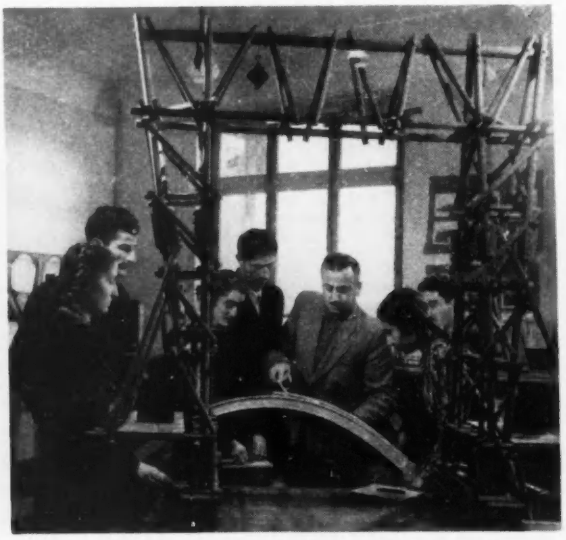
ATHLETICS AND PHYSICAL CULTURE are a must. This is the gymnasium at the Moscow Mining Institute.

MACHINE SHOP PRACTICE is required for all first year engineer students. This is at the Urals Polytechnical Institute.

Russian Engineers (continued)



RAILWAY ENGINEERING INSTITUTE at Leningrad, is one of the oldest in the Soviet Union. Here students are studying a working model of an electric railway system. Note the large number of girls in the class and the woman instructor.



BRIDGE BUILDING LABORATORY at the Railway Engineering Institute, Tbilisi, Georgia. Models play an important role in the Russian engineering training program. Apparently railroad engineering is a popular field for women students.

duate students in this work in the same manner that American faculties direct graduate students. The colleges have their own scientific journals which publish student research.

▶ **Field Experience.** Work practice periods, in which the student is assigned to an actual industrial operation, break up the routine of the fourth and fifth years. At Machine Building Institutes, these periods range between 20 and 22 weeks; at Architectural Institutes 23 weeks; and at Mining Institutes, 27 weeks.

Students travel to their work assignments in the company of an instructor who assumes responsibility for the apprentices during their stay away from school. The state pays all travel and living expenses.

In his first work period, the student learns a limited amount about industrial operation, handling two or three low echelon jobs. But in his last period, he serves as assistant to the heads of various departments.

During the work periods, plant management sets aside special days to orient the working students in seminars conducted by the work practice instructor from the college and selected plant specialists. At these lectures, the students pick up specific details about the plant's operation and an overall picture of the industry.

▶ **Progress Reports Required.** Like the American student in cooperative training, the Russian student prepares a report at the end of each work period. Typical material: a description of the processes of production and equipment he has worked with. But unlike his American counterpart, he must also prepare a critical technical analysis of the work and methods of the plant with recommendations for improvement.

These reports not only check the students progress, but they are forwarded to the industries involved so they can adopt sound student recommendations.

▶ **A Final Project.** After course work and work practice have been completed, the Russian student faces one more test before graduation—the design and "defense" of a graduation project. Usually the university assigns the student to design a complex engineering product in his specialized field. A typical project requires 10 to 15 blueprints and 100 to 120 pages of calculation. It may also require some independent research on the part of the student.

Before the diploma is granted, the student presents his completed project to a state Board of Examiners. They study the completed design while the student defends his approach, use of materials and general design.

When he has passed this board, the state grants a diploma and appoints him to an engineering position at a factory, plant, mine, building job, or railroad. Those who have shown a bent for scientific research are permitted to take a postgraduate course.

▶ **Comes as a Surprise.** This intensive training program and its success may come as a surprise to many American engineers who have felt that Russian engineers were little better than blacksmiths. While certain organizations have attempted to propagandize the U. S. with that idea, there has never been much basis for it.

The Russians are well known for their leadership in certain fields, particularly aerodynamics. In fact, many air frame designs built in the U. S. today are based on Russian calculations, first devised in the 1920's and '30's. Engineering leaders in a number of American aircraft plants have been of Russian origin. They received their academic training in Russia. Notable example: helicopter designer Sikorsky.

Some observers have felt that U. S. technical superiority over continental countries was based on production success rather than pure design. Many educators freely admit that continental education is far more intensive and complete than that in the U. S. But European industries have never been able to develop production know-how that matches the American industrial machine. If the Soviet engineer training program succeeds in developing production experts, that country might well threaten U. S. superiority economically and from a military standpoint.

Defense Department To Push Industrial Security

WASHINGTON—Year end statements by leading diplomats indicate that the chances of an all-out war in 1953 have diminished. But the Defense Department will take no chances with possible espionage or sabotage in armament production. They plan to step up their Industrial Security Education Program started last year.

According to Col. Leroy Hudson, chief of the Munition's Board's Office of Industrial Security, the program is a repetition of World War II security efforts. His office makes recommendations, but they are not mandatory except in plants working on secret items. The campaign will stress making plant employees security conscious.

▶ **Free Help.** To aid management, Hudson's agency has prepared four booklets: "Principles of Plant Protection", "Standards for Plant Protection", "Industrial Security Manual for Safeguarding Classified Material", and "How to be Cleared for Handling Classified Materials".

The first two deal with protecting the physical layout and operations of industrial plants. The others cover the safeguarding of knowledge—blueprints, models, and contracts.

In the standards booklet, the Defense Department lists concrete steps that industry should take. These are grouped under three headings: 1) control of entry, 2) control over espionage and sabotage, and 3) passive defense measures.

▶ **Control of Entry.** Here are typical recommendations for keeping saboteurs and spies out of a plant:

- Enclose all engineering, manufacturing, and storage areas with a fence or wall, a minimum of seven ft high, that has barbed wire running along the top.
- Keep number of openings in this perimeter to a minimum.
- Keep openings guarded or locked at all times and well lighted.
- Maintain unobstructed areas at least 20 ft wide on both sides of the fence.
- Control employees entry including access to restricted areas by use of tamper-proof photo badges.
- Issue identification badges to all visitors and assign guards or responsible officials to control movements within the plant.

▶ **Control Over Espionage and Sabotage.** These are suggestions for sabotage protection:

- Determine in advance those sensitive or vulnerable areas from which production data could be obtained.
- Analyze production processes for possible effective sabotage points.
- Guard electric power generating and distributing equipment as well as communication facilities.
- Keep a close check on all hard to replace equipment and closely watch the fire-fighting system.
- Install protective measures over critical production equipment and manufacturing data files.
- Disperse, where possible, production facilities to prevent concentration of important production centers.

▶ **Passive Defense Measures.** Recommendations for control over normal operating procedures of the plant include:

- Organize plant wide protection organization to cope with possible emergencies.
- Set-up a secondary communications system on a standby basis.
- Communicate evacuation plans to employees and hold scheduled drills.
- Plan for the restoration of essential production after accidents or enemy action.

U. S. Army Photo

WORKMAN tries out the Army's new high frequency 12-in. electric power saw currently under test at Ft. Belvoir, Va.

Army Studies 180-Cycle Power Tools For Front Line Troops

FT. BELVOIR, VA.—Scientists at the Engineer Research and Development Laboratories are currently testing a set of portable 180-cycle electric power tools developed by major commercial manufacturers. If the new tools pass these tests, they will permit front line combat engineers to expend their duties and boost their productive capacity.

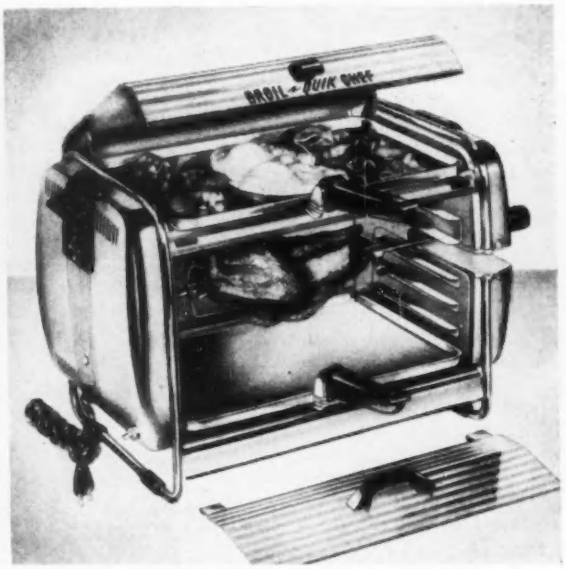
Under study: two chain saws, two circular saws, two drills, two impact wrenches, a grinder, and an electric hammer. ERDL is also studying the performance of a specially developed 180-cycle, 220 v, 3-phase, 2½ kw engine generator set that is to supply electricity to operate the tools.

EDRL hit on the higher frequency in an effort to cut the weight of generating equipment and motors. From a military standpoint, they wanted an apparatus that would be easy for ground forces to move around and could be dropped from aircraft by parachute.

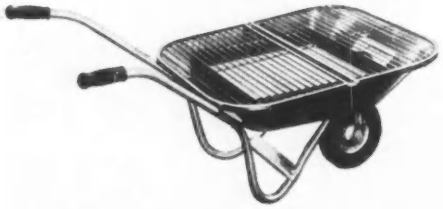
The generator is driven by one of the Army's new standard gasoline engines and is light enough to be carried by two men. The outfit fits into a ¼ ton trailer which, when loaded with the generator, tools and floodlights, weighs only 1,370 lb.

The Army hopes that the electric equipment will replace pneumatic tools now used. Because these require a heavy air compressor, front line troops can't move them around under fire.

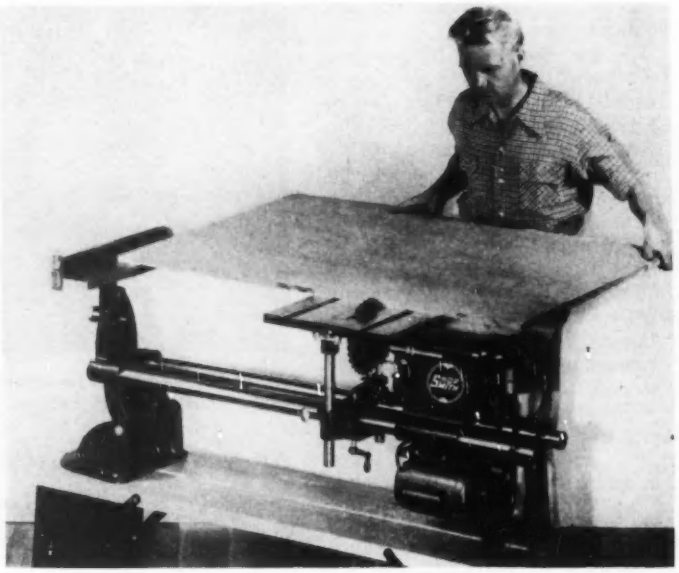
LIMITED SPACE KITCHEN APPLIANCE, combining sink, range, refrigerator and storage space in one unit, won grand prize for the General Air Conditioning Corp.



INFRA-RED BROILER AND ROTISSERIE combination won an honorable mention award for its manufacturer, the Broil-Quick Company. It broils, grills, fries, barbecues and roasts.



GARDEN BARROW, made by Northwest Metal Products, has a triple function: as a streamlined wheelbarrow, a portable barbecue, or an outdoor server. It indicates how style- and appearance-conscious houseware designers have become.



MULTI-PURPOSE WOOD WORKING TOOL can do over one hundred jobs in the home or professional shop. Made by Magna Engineering Corporation, the ShopSmith won honorable mention award in the home appliance class.

Contest Rewards Versatility in Design

THE CONSUMER PRODUCTS pictured above have two things in common:

- Each won a prize or honorable mention in the 1952 Versatility in Design Contest sponsored by Hess Brothers, Allentown, Penna., department store.
- Each performs more than one function; it replaces two or more products with one unit.

Hess Brothers sponsors this contest annually to honor manufacturers for the practicableness of their products, with a particular slant on multiple functions. Grand prize winners get placques; honorable mentions, scrolls.

Multiple purpose appliances and tools represent a new design trend that is becoming more prominent in both consumer and industrial fields. Sales departments have started pressing their engineering departments to make goods more attractive to customers by: 1) increasing the number and quality of automatic features, 2) boosting versatility so that one device will do the job previously accomplished by several, 3) reducing costs with new materials and production techniques that are less expensive but which maintain or improve quality.

Industrially, this trend appears in new automatic machine tools, computer-operated devices, automatic production lines and even proposed automatic factories.

TECHNICAL NEWS BRIEFS

LAST MONTH, eight students from Virginia Polytechnic Institute inaugurated cooperative training at the Engineer Research and Development Laboratories, Ft. Belvoir, Va. Assigned for a six month period, the student engineers were placed in positions according to their present level in school. Pay scales depend on previous education and experience, and are in accord with Civil Service requirements. The students will live on the Army post, subject to the same regulations as other civil servants. Eventually, Ft. Belvoir plans to increase the number to 20 cooperative training students, seeking degrees in physics and engineering.

MICROWAVE SPECTROGRAPH at the Armour Research Foundation of Illinois Institute of Technology will be used to identify gases, to determine the concentration of gases in mixtures, and to study molecular and atomic structures. Like a visible light spectrograph, the new instrument uses electromagnetic radiation. But radar equipment supplies microwaves instead of light. It uses the fact that gases at low pressures absorb microwave power at sharply defined frequencies that are characteristic of each gas. When accurately measured, these frequencies identify the gases.

ELECTRONIC PAINT SPRAYING is simplified by a new spray gun developed by Scientific Electric, Garfield, N. J. In the new unit, paint in the spray gun is charged electronically; previous methods of electronic spraying required the use of external electrically charged screens. The manufacturer claims that the ionized paint can differentiate between painted and unpainted surfaces so that it produces an even finish. They also claim paint loss is reduced to less than two percent of the paint sprayed.

TANNIC ACID, in concentration greater than 0.01 percent, stops the corrosive action of sulfate reducing bacteria that corrodes iron and steel buried in the soil. English archaeologists discovered this while they were excavating ruins at Hungate, York. They found iron implements, over 2,000 years old, perfectly preserved even though they were buried in soil with a high sulphur concentration. Further studies indicated that a leather tannery had occupied the site and discharged tannates into the soil. Chemical analysis found that tannates imbedded in the surface of the implements had arrested corrosion.

COMPOUNDED POLYVINYL CHLORIDE developed by Calresin Corp., Acadia, Calif., serves as a shock proof military packaging material because it can withstand low temperatures, does not compress to the same extent as air foam products, and is more flexible than rubber particles. Called "CPC", the new material can be molded in any shape to fit the article it is to protect; it can be molded with a covering of cloth; and it can be bonded to any known surface.

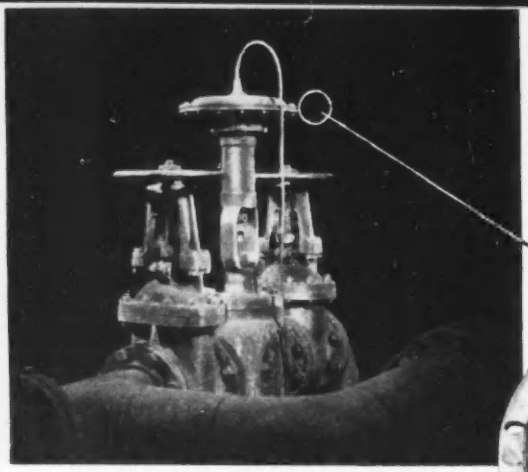
CATALYSTS that speed up chemical reactions are the key to a new low-cost process which makes cold rubber 50 times faster than current methods. According to the developers, the B. F. Goodrich Chemical Company, the new method produces synthetic rubber in 15 to 20 minutes instead of 10 to 12 hr. Price reductions may be possible because the new process uses less expensive equipment and buildings. While they are still working with pilot plants, Goodrich engineers estimate that the new buildings and equipment for the process will cost 50 percent less than conventional rubber-producing operations.

NEW ELECTRICAL RADIANT HEATING PANEL may find uses in machine design, to apply heat to surfaces of machinery. Made of thin sheets of conductive rubber sandwiched between layers of plastic and aluminum foil, the panels are only $\frac{1}{16}$ in. thick, weigh six oz per sq ft, and are rated at 22 watts per sq ft (75 BTU's). A special adhesive cements the new panel to any kind of smooth surface. Both the surfaces have aluminum foil covers to seal out moisture. Called Uskon, the panel is made by the United States Rubber Company.

METAL POWDER ASSOCIATION has announced two standards for self-lubricating bearings made of sintered metal powders and impregnated with oil. One, released in June, 1951, established a list of preferred bearing sizes commonly available from all manufacturers as well as correlating bearing dimensions with stock shaft sizes. The newest standard—16-52T, "Specifications for Metal Powder Sintered Bearings (Oil Impregnated)"—is identical to ASTM Standard B202. The two MPA standards permit users of these bearings to find standard information in one place.

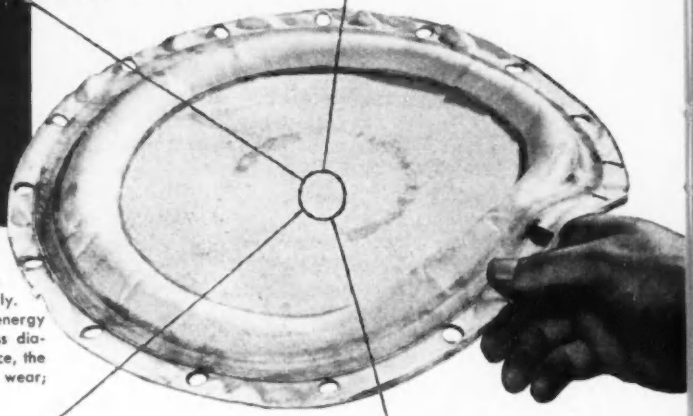
COLMONOY SPRAYWELDED hard-facing alloys increase life of parts subjected to heat and wear up to 54 times. Applied by powder metal spraying, the hard-surface alloy provides a non-porous, fusion bonded, wear resistant surface up to 0.060 in. thick. Properties of the alloy include: high resistance to oxidation at elevated temperatures; plasticity over a wide temperature range, 1850 to 2050F, permitting it to be bonded to steels, stainless steels, and some copper and cast iron alloys without flowing or losing its shape; and resistance to most acids and all strong alkalis.

FIRST DELTA WING SEAPLANE, the XF2Y-1 "Sea-Dart" takes off from San Diego Bay in pre-flight trial runs. It is also the first combat aircraft to use hydro skis for landings and take offs. Built by Consolidated Vultee Aircraft Corporation, the craft has no horizontal tail, instead, it is equipped with a triangle-shaped vertical fin and rudder. Two Westinghouse turbojet engines power the seaplane.



The diaphragm in this valve that regulates the intake to a boiler feedwater storage tank, is in almost constant motion 24 hours a day at temperatures well above 100°F. Successive synthetic rubber diaphragms lasted 7, 11 and 13 months respectively. That's unsatisfactory performance in a power house supplying energy to a large chemical plant. So they tried a Silastic coated glass diaphragm. Recently inspected after more than 78 months of service, the Silastic diaphragm was still soft and flexible; showed little wear; appeared serviceable for many more months.

As a valve diaphragm at +100°F SILASTIC outlasts heat-stable organic rubber 7 to 1



For maximum life and reliability

specify SILASTIC*

the durable silicone rubber

You, too, will find that Silastic will last longer and give you more reliable service in most applications where the life of organic rubbers is limited by high temperatures, oxidation or weathering. You will also find that Silastic can be used in many cases to take the place of complicated mechanical devices made necessary by the relative instability of organic rubber.

And Silastic is in a class by itself among rubbery materials. For example, we have aged typical samples of a Silastic stock for 12 months in an air circulating oven at 350°F. After such accelerated aging, those samples showed an increase in hardness of only 18 points from 46 to 64 durometer; elongation went down from 320 to 105%; tensile strength dropped only 26 points from 557 to 531 p.s.i.; and there were no significant changes in any of their dielectric properties.

And that is almost incredible performance at temperatures high enough to change any other kind of rubber to a brittle, noninsulating material in a few hours or days at the most. When you need rubbery properties or good dielectric properties in a resilient material that will withstand weathering or long exposure to temperatures above or below the limits of ordinary rubbers, specify Silastic.

*T. M. Reg. U. S. Pat. Off.

Mail Coupon Today

Dow Corning Corporation, Dept. R-2, Midland, Michigan.

Please send me:

- ☐ List of Silastic Fabricators
- ☐ Silastic Facts 10a
- ☐ "What's A Silicone?"

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

FIRST IN SILICONES

DOW CORNING CORPORATION

ATLANTA • CHICAGO
CLEVELAND • DALLAS
NEW YORK • LOS ANGELES
WASHINGTON, D. C.
MIDLAND, MICHIGAN
In Canada:
Fiberglas Canada Ltd., Toronto
In England:
Midland Silicones Ltd., London

A Practical Method for Designing Gear Trains

M. F. SPOTTS
Northwestern University

IT IS USUALLY DIFFICULT to choose suitable numbers of teeth for a gear train that is used to get a specified relative rotation between two parts of a mechanism. This is particularly true when the ratio must be controlled to several decimal places, as required in Fig. 1 which shows the change-gears of a thread cutting lathe.

Several involved mathematical processes are available for solving such problems. In general, however, an exact solution is impossible because the numbers of teeth must be integers. If practical results are the main consideration, the following method can be used to get results readily that are very close to the desired value. Some trial and error work is necessary, but it is kept to a minimum.

The value of the given ratio is represented by G, and a/b is a common fraction, whose value is close to that of G, a and b being integers.

Ratio G is commonly expressed as:

$$G = \frac{N_1 \times N_3 \times N_5 \cdots}{N_2 \times N_4 \times N_6 \cdots}$$

It can also be expressed as:

$$G = \frac{ah - m}{bh} \qquad (1)$$

where m is an integer, and h is a quantity to be determined. Rearranging Eq (1), it can be expressed as:

$$h = \frac{m}{a - bG} \qquad (2)$$

In Eq (1) both numerator and denominator must be integers factorable into terms suitable for use as the numbers of teeth in the gears. Thus h must be an integer, something that rarely occurs by substitution into Eq (2). However, if an integer h' whose value is close to that of h is used in Eq (1), the result G' may be sufficiently close to the desired value G. The equation for G' is

$$G' = \frac{ah' - m}{bh'} \qquad (3)$$

EXAMPLE: The shaft A in Fig. 2 is to make 2.54 turns for each revolution of the shaft B. Find suitable numbers of teeth for the gears of the train.

SOLUTION:

$$G = \frac{1}{2.54} = 0.3937008$$

By trial, fraction 35/89 has a value close to G. Hence

$$\frac{a}{b} = \frac{35}{89}$$

If m is given a value of unity, from Eq (2)

$$h = \frac{1}{35 - 89 \times 0.3937008}$$

$$= \frac{1}{-0.03937} = -25.399$$

Taking

$$h' = -25,$$

$$G' = \frac{-35 \times 25 - 1}{-89 \times 25}$$

$$= \frac{876}{2,225} = 0.3937079$$

If this value for G' is sufficiently close to the given value of G to meet specified requirements, fraction 876/2,225 must now be factored. Thus

$$\frac{876}{2,225} = \frac{12 \times 73}{25 \times 89}$$

(continued on page 213)

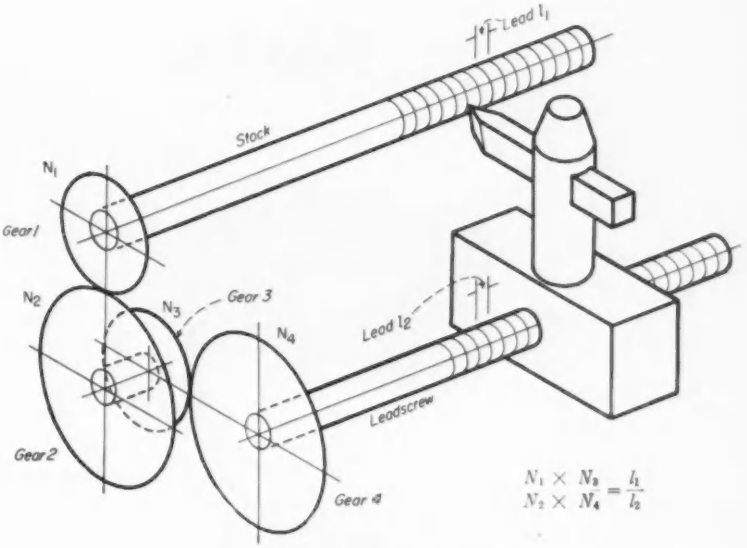


Fig. 1—Thread being cut by lathe.

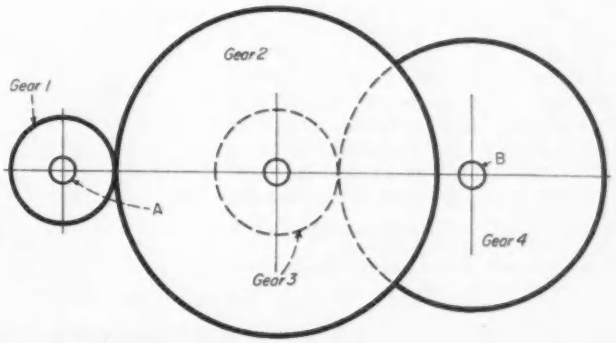


Fig. 2—Gear train consisting of four gears.

You're always right with AUTO-LITE

Plastics

• Plastics and plastic-metal combinations are opening new fields in design as illustrated by these few of many assemblies made by Auto-Lite. Here under one roof at Auto-Lite's great Bay Manufacturing Division in Bay City are the technical skills and production capacity for a new art rendered in plastics. The artistic skill of Auto-Lite's Art and Style Division is available on matters of design and development. Address inquiries to:

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
723 New Center Bldg., Detroit 2, Mich. • Bay City, Mich.

Tune in "Suspense" . . . CBS Radio Mons. . . . CBS Television Tues.

PLASTICS • WIRE & CABLE • DIE CASTINGS • INDUSTRIAL THERMOMETERS

A Practical Method for Designing Gear Trains (continued)

These numbers can be used for $N_1 \times N_3/N_2 \times N_4$.

Other solutions can be obtained by taking different values of m. For example, if $m = 7$,

$$h = \frac{7}{35 - 89 \times 0.3937008}$$

$$= \frac{7}{-0.03937} = -177.79$$

The next step is selecting an integer for h'. For example,

$$h' = -178$$

$$G' = \frac{-35 \times 178 - 7}{-89 \times 178}$$

$$= \frac{6,237}{15,842} = 0.3937003$$

This can be factored as follows:

$$\frac{6,237}{15,842} = \frac{7 \times 11 \times 81}{2 \times 89 \times 89}$$

Numbers suitable for use as teeth for the gears can be obtained by multiplying numerator and denominator by the same factor. If six is used, then the factors become:

$$\frac{21 \times 22 \times 81}{12 \times 89 \times 89}$$

Although this train consists of six gears, it should be noted that the ratio is much closer the required value than the first result consisting of four gears.

Both numerator and denominator in Eq (3) must be factorable into numbers which can be used for the teeth of the gears. This can be done only by trial and error. A table of prime numbers such as is given in Machinery's Handbook can be used for this.

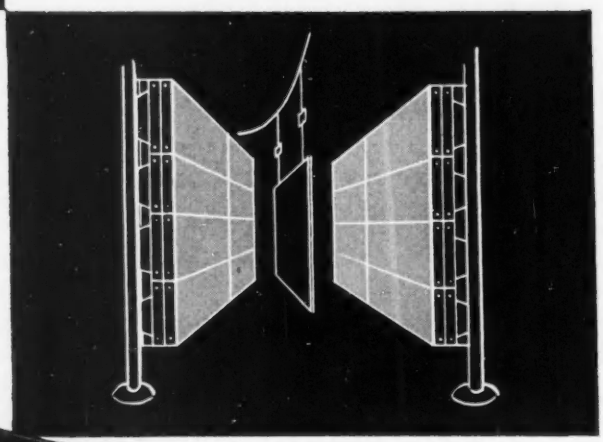
In machining operations it is frequently necessary to convert from the Metric to the English systems of measurement. For this purpose the ratio of the example, 1 to 2.54, is used. Table I lists a number of gear trains suitable for making this conversion.

Table I—Solutions for the ratio, $G = \frac{1}{2.54} = 0.3937008$

a	b	m	bG	$a - bG$	$h = \frac{m}{a-bG}$	h'	$G' = \frac{ah' - m}{bh'}$	Suitable Gears
137	348	1	137.00788	−0.00788	−126.9	−128	$\frac{-137\times128-1}{-348\times128} = \frac{17,537}{44,544} = 0.3937006$	$\frac{13\times19\times71}{16\times32\times87}$
74	188	3	74.01575	−0.01575	−190.48	−190	$\frac{-74\times190-3}{-188\times190} = \frac{14,063}{35,720} = 0.3937010$	$\frac{7\times41\times49}{19\times40\times47}$
87	221	1	87.00788	−0.00788	−126.9	−128	$\frac{-87\times128-1}{-221\times128} = \frac{11,137}{28,288} = 0.3937005$	$\frac{7\times37\times43}{26\times32\times34}$
35	89	7	35.03937	−0.03937	−177.79	−178	$\frac{-35\times178-7}{-89\times178} = \frac{6,237}{15,842} = 0.3937003$	$\frac{7\times11\times81}{2\times89\times89}$
345	876	4	344.8819	0.1181	33.87	34	$\frac{345\times34-4}{876\times34} = \frac{11,726}{29,784} = 0.3937013$	$\frac{11\times13\times41}{12\times17\times73}$
61	155	2	61.02362	−0.02362	−84.66	−85	$\frac{-61\times85-2}{-155\times85} = \frac{5,187}{13,175} = 0.3937002$	$\frac{13\times19\times21}{17\times25\times31}$
48	122	3	48.03150	−0.03150	−95.244	−95	$\frac{-48\times95-3}{122\times95} = \frac{4,563}{11,590} = 0.3937015$	$\frac{13\times13\times27}{10\times19\times61}$
93	236	7	92.91339	0.08661	80.822	81	$\frac{93\times81-7}{236\times81} = \frac{7,526}{19,116} = 0.3937016$	$\frac{53\times71}{2\times59\times81}$
102	259	2	101.9685	0.0315	63.50	63	$\frac{102\times63-2}{259\times63} = \frac{6,424}{16,317} = 0.3936998$	$\frac{73\times88}{7\times37\times63}$
37	94	1	37.00788	−0.00788	−126.98	−129	$\frac{-37\times129-1}{-94\times129} = \frac{4,774}{12,126} = 0.3936995$	$\frac{11\times14\times31}{6\times43\times47}$
22	56	5	22.04724	−0.04724	−105.83	−106	$\frac{-22\times106-5}{-56\times106} = \frac{2,337}{5,936} = 0.3936994$	$\frac{3\times19\times41}{2\times53\times56}$
111	282	2	111.02363	−0.02363	−84.638	−83	$\frac{-111\times83-2}{-282\times83} = \frac{9,215}{23,406} = 0.3937025$	$\frac{95\times97}{6\times83\times47}$

Armco ALUMINIZED Steel solved this reflector problem

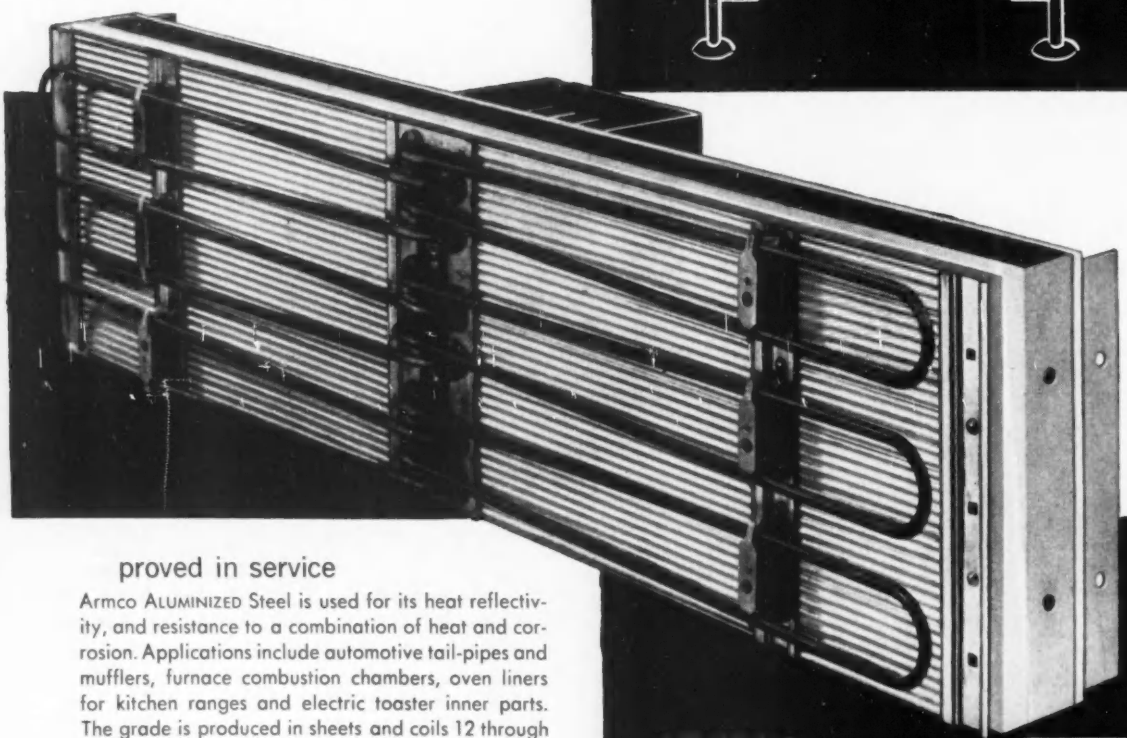
Heating panels for intense infra-red radiant heat need reflectors that are efficient, long-lived and rugged. A prominent manufacturer of electric radiant panel units has found that Armco ALUMINIZED Steel meets all of these requirements.



His reflectors operate on a wave length of 4 microns at 900 degrees F. Even at this temperature the aluminum coating stays bright. It maintains its reflective efficiency because of its resistance to oxidation, and protects the steel base.

the steel base means strength

In addition to their excellent heat-reflectivity, panels made of Armco ALUMINIZED Steel assure rugged strength. Corrugations in the steel give rigidity to "take" hard knocks and vibration at the 900-degree F reflector operating temperature.



proved in service

Armco ALUMINIZED Steel is used for its heat reflectivity, and resistance to a combination of heat and corrosion. Applications include automotive tail-pipes and mufflers, furnace combustion chambers, oven liners for kitchen ranges and electric toaster inner parts. The grade is produced in sheets and coils 12 through 30 gage—up to 48 inches wide in certain gages.

write us

If you need a heat-reflective or heat-resistant metal, write us for the descriptive booklet, "Armco ALUMINIZED Steel."

ARMCO
STEEL CORPORATION
1523 Curtis St., Middletown, Ohio • Export: The Armco International Corporation

Nomogram for Evaluating Test Data

EDWARD C. VARNUM
Barber Colman Company

TO COMPARE two sets of data, it is often necessary to know if their averages differ significantly or if the observed difference has arisen by chance alone. To answer such questions, statisticians have devised a set of rules for determining whether or not the average of one set of data is significantly different from the average of another set. This is known as the "t test" and although it is described in standard statistics texts, the accompanying nomogram facilitates the calculation.

Assuming that there are the same number of observations in each set of data, a quantity called the "variance" can be calculated for each set.

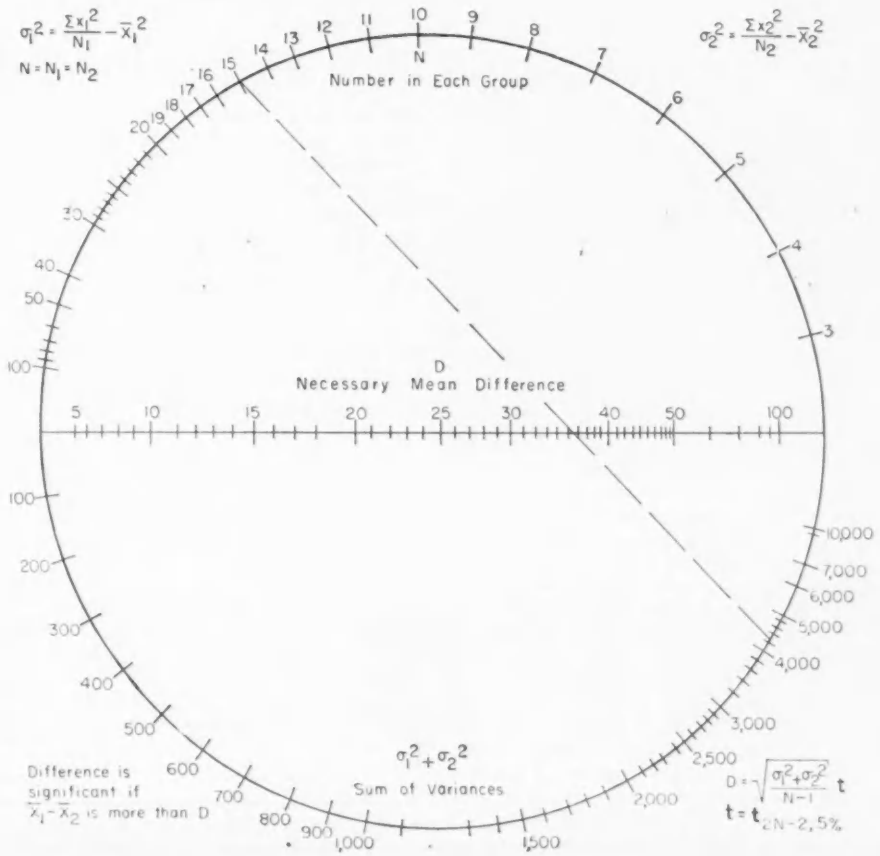
For the first set the variance is given by

$$\sigma_1^2 = \frac{\Sigma x_1^2}{N_1} - \bar{x}_1^2 \qquad (1)$$

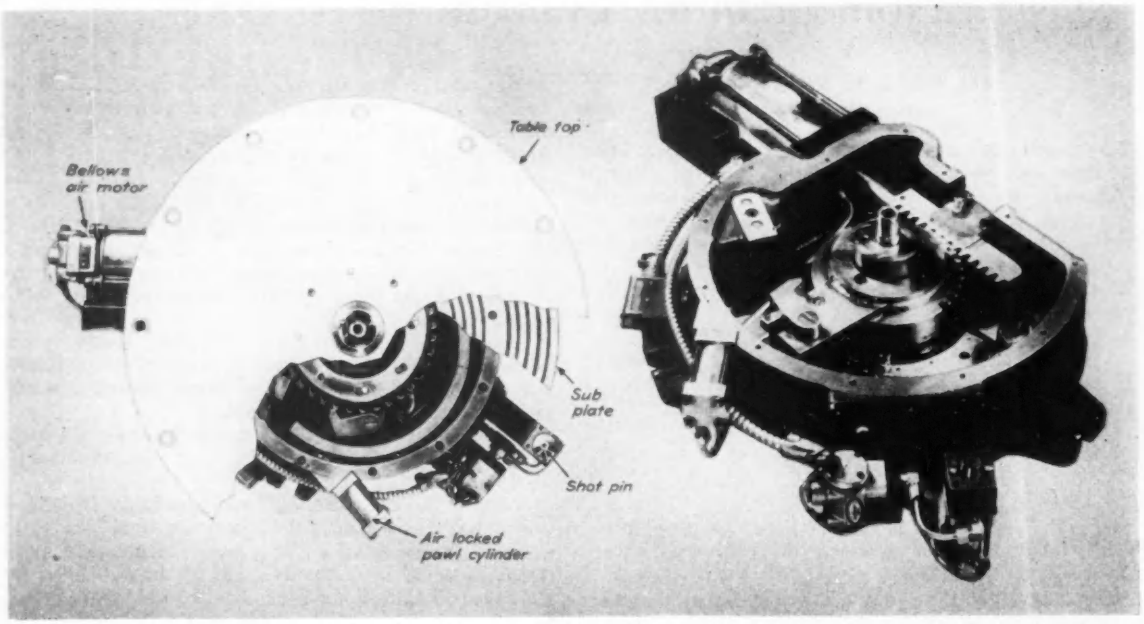
where Σx_1^2 signifies the sum of the squares of the observed values and $\bar{x}_1$ indicates the average of the observed values. In words, the above equation says that the variance of a set is the square of the average taken away from the average of the squares. The variance for the second set is calculated in the same manner and the two variances are added. By finding the number corresponding to this sum on the lower semicircle of the nomogram and connecting this value to the number of observations in each set which appears on the upper semicircle, the line joining these values will cross the diameter at a value which is labeled the "necessary mean difference". If the actual difference is greater than this necessary mean difference the difference is significant. In the more precise language of the statistician, the difference is *significant at the five percent level* if the actual difference exceeds the *nmd* found by the nomogran, which means that there is less than one chance out of twenty that the observed mean difference would occur when no real difference exists.

Example: One group of data which consists of 15 items has a variance of 1444. Another group of 15 items is found to have a variance of 2809.

Solution: Since the sum of the two variances is 4253, a line is drawn as shown in the nomogram from N = 15 to 4253 on the lower scale. This gives the necessary mean difference as 35.7. If the averages of the two differ by more than 35.7, the difference is significant.


$\sigma_1^2 = \frac{\Sigma x_1^2}{N_1} - \bar{x}_1^2$
$N = N_1 = N_2$
Number in Each Group
N
$\sigma_2^2 = \frac{\Sigma x_2^2}{N_2} - \bar{x}_2^2$
D
Necessary Mean Difference
$\sigma_1^2 + \sigma_2^2$
Sum of Variances
Difference is significant if $\bar{x}_1 - \bar{x}_2$ is more than D
$D = \sqrt{\frac{\sigma_1^2 + \sigma_2^2}{N-1}}\, t$
$t = t_{2N-2,5\%}$

NEW COMPONENTS-



THE TABLE FEEDS WORK TO, and under drill press spindles, milling cutters, impact press rams, riveting heads and other machines. A gear rack drives a quadrant gear which rotates the table top a predetermined number of degrees in a clockwise direction.

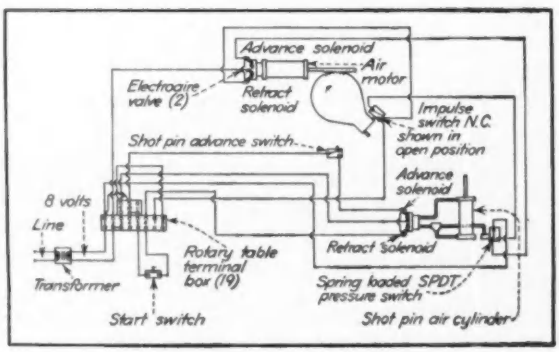
Air Powered, Rotary Index, Positioning Table

An electrically controlled, air powered rotary index work feeder, has a 26 in. dia table top that is set to index either 6, 9 or 18 stations with repeat index accuracy of ±0.001 on the table top.

The accuracy of rotary index table is said to be the result of a "shot-pin" arrangement. Around the perimeter of the table top are 18 equally spaced, jigbored holes, tapered and bushed to $\frac{3}{4}$ in. diameter. An auxiliary air cylinder, controlled by an additional electroaire valve and synchronized to the movement of the table, drives a tapered shot-pin into the jigbored hole, locking the table, after cushioned air power has moved it into position.

The detailed operation of the rotary index table can be followed on the wiring diagram. When an electrical circuit is completed through external connections to terminals 5 and 6 in terminal box (19), it energizes the retract solenoid of the electroaire valve (1) used to control the auxiliary air cylinder which operates the "shot-pin." The shot-pin retracts, releasing the index table top. As the shot-pin retracts, pressure drop in the auxiliary air cylinder exhaust line, allows the pressure switch to take the position shown in the drawing. Current flows through the pressure switch and energizes the advance solenoid of the built-in electroaire valve (2) on the $3\frac{5}{8}$ in. bore air motor. This causes the piston rod to advance and, through a rack, quadrant gear and air-locked pawl, index the table. As the table indexes to position, it trips the N.O. shot-pin advance switch, energizing the advance solenoid of the electroaire valve (1) causing shot-pin auxiliary air cylinder to advance and drive the shot-pin into the tapered hole in the table top, locking the table into position. High pressure air, tapped from the advance side of the shot-pin air cylinder, reverses the pressure switch, sending current through the N.C. impulse switch to both the retract solenoid of electroaire valve (2) and to terminal 7 in terminal box (19) (to provide an impulse source to operate auxiliary equipment.) The air motor piston rod retracts, the pawl overrides the table top gear, the table still being held in its "shot-pin-locked" position. When the air motor piston rod reaches its fully retracted position, an adjustable trip opens N. C. impulse switch, and the index table is ready to repeat another cycle to be initiated by contact, manual or automatic, through terminals 5 and 6.

Bellows Co., 230 W. Market St., Akron, O.



Easily Installed Broach-Fit Bushings

Having such applications as valve stem guides, pulley bushings, rocker arm bushings, swing pin fulcrums, and dowel pin guides, these headless bushings can be forced into parts of cast metal, plastics, steel, and other metals without the necessity of close tolerance press fits. The bushing has a broached outer surface giving cutting edges that eliminate the need for high precision boring and reaming. They will work satisfactorily with a maximum tolerance of 0.002 inch, as compared to some requirements of 0 to 0.0005 inch.

One end of the bushing has a pilot which is slightly smaller in diameter than the broached surfaces. This squares the bushing with the hole, reducing the possibility of cocking or tipping during the assembly. As the bushing is locked into position, no set screws or locking devices are required. However, the bushing may be removed, if necessary, and replaced without reworking the hole.

Because of the broaching action, the manufacturer claims that the bushing can be inserted with less possibility of collapse and without danger of cracking castings, jigs, fixtures, or other parts, particularly when made of cast metals or plastics.

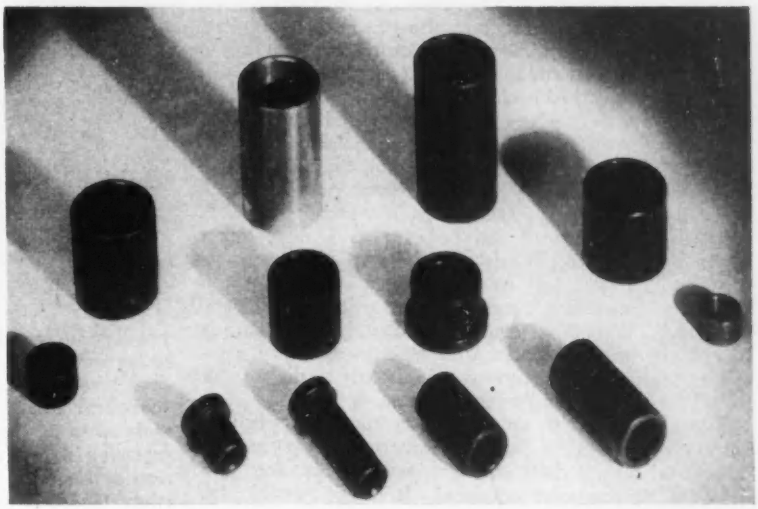
The bushings are made of hardened steel treated with a black oxide penetrate which prevents rust and corrosion.

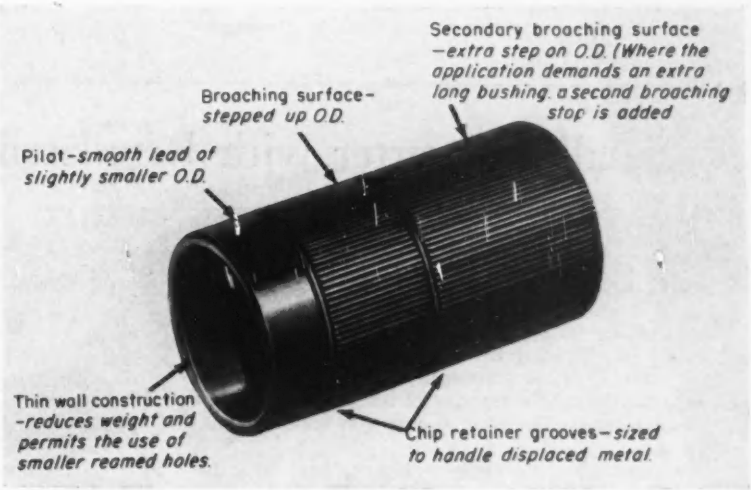
Broach-fit bushings with heads are also available for applications such as: drill jigs; rivet templates; jig rest buttons; pin anchors; locator buttons for jigs and fixtures; and wear buttons for machine parts.

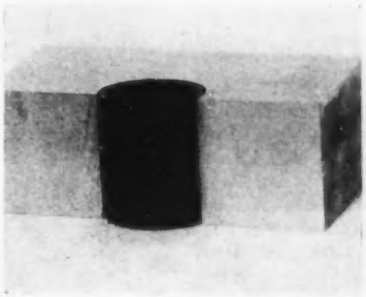
The headless bushings come in lengths from ¼ to 1 inch, with internal diameters from 3/16 to ¾ inch. The head bushings have lengths from 5/16 to 1 inch, with internal diameters from 1/16 to ½ inch.

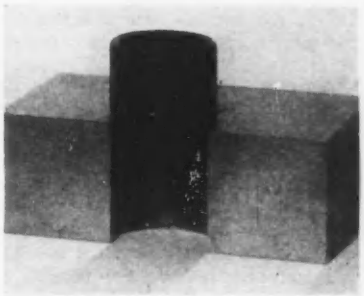
Other typical applications for the headless bushings are: stop pin location holes; cable and chain guides; hole reinforcements in die castings and plastics; die liners for short run sheet metal jobs; build ups for washed out holes; and swing plate hinges.

Aeroquip Corp., Jackson, Mich.




Secondary broaching surface —extra step on O.D. (Where the application demands an extra long bushing, a second broaching stop is added
Broaching surface—stepped up O.D.
Pilot—smooth lead of slightly smaller O.D.
Thin wall construction —reduces weight and permits the use of smaller reamed holes.
Chip retainer grooves—sized to handle displaced metal.





CONTINUED ON PAGE 218

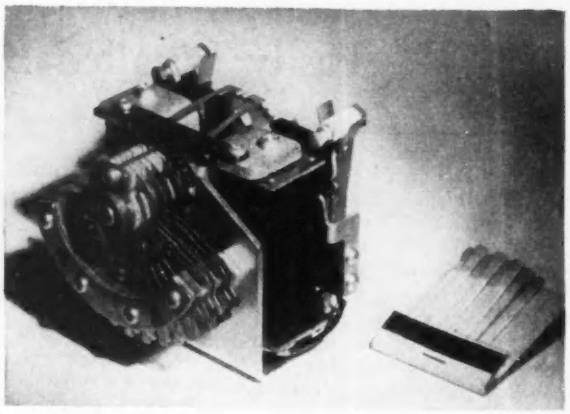
Stepping Switch for Advancing And Reversing

Capable of advancing or reversing with equal speed, a new model 27000 Bi-Directional stepping switch is adaptable to a variety of applications: such as types of high-speed, differential counter, and servo-mechanism designs. In addition to its use as a bi-directional switch in circuits requiring contact closures, it is also convertible to a stepping motor for special servo and control applications.

As a differential counter, the unit is used to indicate a remaining quantity or balance on hand, such as in a hopper or processing unit, where each unit inserted advances the switch, and each unit taken out or completed reverses it one step. As a remote positioning motor, the switch mechanism can be controlled by bi-directional remote sources, such as dials or shafts having stops at separate points. In automatic computers, it can be used as a digit-storage register, a single switch being able to add or subtract over separate control paths. As an automatic attenuator, it is used to add or subtract resistances for adjusting gain and preventing overloads. And as a digital, self-balancing bridge, the switch, together with separate resistance steps, converts analog test or process data directly to digital contact closures available for computation or control.

External pulses of short duration can be applied to advance or reverse the shaft and wipers one step for each pulse, and an interlock prevents partial steps due to a defective control pulse or signal. It is not possible for the wipers to be positioned between steps.

The switch mechanism, an electro-magnetically operated pawl and ratchet, steps the output shaft to 36 angular



positions in 10 deg. steps. Drive is direct, since shaft movement occurs upon energization of the coil rather than through the use of springs. A typical switch has four parallel circuits to 12 positions. Special contact banks with up to 25 contact positions can be furnished, and by replacing a level of contacts with a solid metal sector to provide center feed to the wipers, full 360 deg. rotation is obtained over 36 contacts.

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Small Converter with Regulated Output

A new totally enclosed, 300 watt 6120/20 frame power conversion unit having a variety of uses, has a d-c input of 115 V ±15 percent, and a 60 cycle regulated a-c output of 115 V, single phase, operating at 0.9 lagging power factor.

The regulated output of this conversion unit is accomplished by compounding the booster field winding. This output is filtered for suppression of radio noise by a filter unit which is located in the control box mounted on top of the rotary unit. The filter as a unit is removable for maintenance.

Mounted on top of the converter is a box containing the filter and all control devices used on it, plus the starting contactors, output voltage control, and the other necessary circuit components. In addition to these essentials, the box also accommodates spare parts such as brushes and fuses.

To cool this converter, the unit was designed so that a fan built in at one end would pass cool air over the exterior frame. The maximum dimensions needed to mount this unit are: $16\frac{13}{16}$ in. by $12\frac{5}{8}$ in. by $8\frac{7}{16}$ inches. Mounting dimensions are: mounting centers, $3\frac{7}{8}$ by $6\frac{1}{4}$ in. The complete unit weighs approximately 60 pounds.

The base, box, and covers are manufactured from anodized cast aluminum, and the cover plates are made from cadmium-plated steel. For possible use in tropical zones

and in sea coast areas, the unit has been built according to MIL specifications to withstand corrosion, fungus, and salt spray.

Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.

CONTINUED ON PAGE 220

CONTINENTAL'S PROOF BOOK

Stanley Webber

Purchasing Agent for the Compo Shoe Machinery Corporation of Boston. His many years of experience in this capacity are requisites for the responsibility of all purchases in a company so widely known for many types of high quality shoe machinery.

COMPO SHOE MACHINERY CORPORATION

150 CAUSEWAY STREET · BOSTON, MASS.

NEW YORK · ST LOUIS · CINCINNATI · PHILADELPHIA · LOS ANGELES · HAVERHILL · AUBURN, ME. · CHICAGO

Continental Screw Company
New Bedford
Massachusetts

Gentlemen:

The casual observer probably does not realize what a vital role fasteners play in the shoe manufacturing industry, especially in the attachment of heels to ladies' shoes.

On various occasions you have been called to sit in with our Engineering Department for the purpose of designing and manufacturing special screws which are tending to give longer life to this type of footwear.

We are deeply appreciative for the advantages we have gained as a result of this close alliance, advantages which have been obtained principally through the efforts of your highly skilled technical staff.

Yours truly,

COMPO SHOE MACHINERY CORP.

Stanley Webber

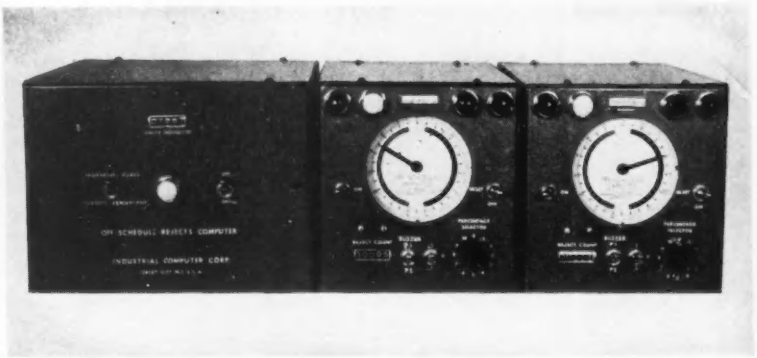
You too can count on Continental®

CONTINENTAL SCREW COMPANY INC. 1904

Manufacturers of HOLTITE Fastenings For Every Purpose

CONTINENTAL SCREW COMPANY, NEW BEDFORD, MASS., U.S.A.

Off-Schedule Rejects Computer



The off-schedule rejects computer for centralized quality control continuously computes and indicates directly the quality of an inspected product by indicating any deviation from a predetermined normal expected reject percentage, whether it is on a straight percentage basis or a probability curve.

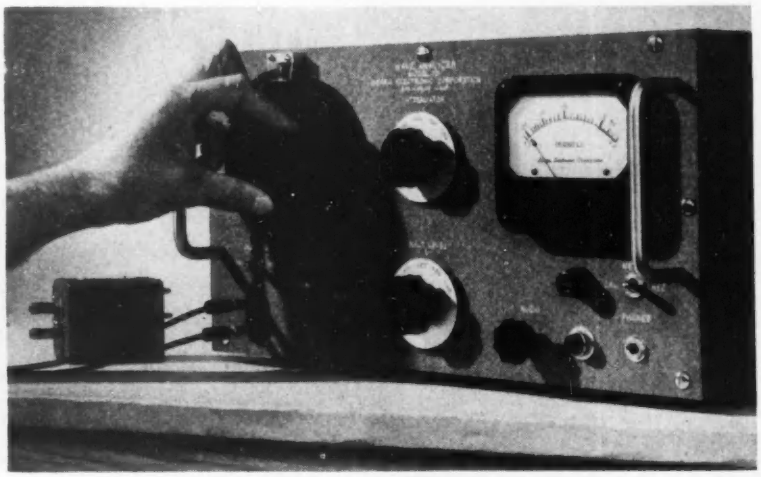
The computer consists of a master computing unit and a number of individual computing and indicating units, the number depending on the number of characteristics for which a product is inspected. The individual units are connected to the master unit by means of plugs and cable connected to the rear. The master computing unit has an on-off switch and light, and a switch to operate the system on a straight percentage or on a probability curve basis. Being flexible, it can be adapted to operate on both basis at the same time, as where some of the expected rejects of certain characteristics occur on a straight percentage basis, while the expected rejects for other quality characteristics follow a probability curve. The master unit is designed to follow the standard rejects probability curves, generally accepted in the quality control field; but, any other specified curves can be provided. A counter shows the total number of production units inspected.

The individual computing and indicating units, one for each quality characteristic, indicate directly the quality for that particular characteristic. Each individual unit has an indicating dial to show whether the actual number of rejects are above or below the predetermined control limit. To supplement the dial, four indicating lights and a warning buzzer are provided. The warning buzzer goes on when a predetermined critical deviation point has been reached. Percentage rejects selector switches make possible a selection range of 0.1 to 1 percent and 1 to 10 percent. Because of the flexibility of the system other specified ranges can be provided. Also on each unit is a reject count so that the actual number of rejects for the particular characteristic is visible at all times.

Where the quality of a product is on an hourly basis, the individual units can be reset by means of a momentary switch without disturbing the function of the master computing unit. There is no limit to the number of production units that can be inspected, or the number of individual units that can be controlled by the master unit. Only two wires need to be brought from the inspection station to each unit. The power consumed per unit is 4 watts plus 6 watts for the indicating lights, 110 v a-c. The master units measure 7¾ in. high, 11 in. wide, and 10 in. deep.

Industrial Computer Corp., 272 Lembeck Ave., Jersey City, 5, N. J.

15 to 500 Kc Wave Analyzer



Analysis of the frequencies and amplitudes of signal components in a complex wave form is accomplished with the new model 121 wave analyzer, which permits a wide range of measuring amplitudes without the introduction of instrument distortion.

Designed for application to transmission-characterisitc determinations of electric-wave filters; for induction and signal level studies on carrier telephone systems; for measurement of distortion products in r-f signal sources and transmitters, the instrument has an input level range from +42 dbm to —70 dbm at 600 ohms impedance.

Signal components are read directly on a calibrated instrument. Selectivity is such that at 1,000 cps off resonance, the response is 45 db down. Measuring accuracy is ±2 decibels.

Sierra Electronic Corp., 830 Brittan Ave., San Carlos, Calif.

CONTINUED ON PAGE 222

FOR SAFER CONTROL ⟶⟶⟶ OF HARD-TO-HANDLE FLUIDS

CRANE Packless Diaphragm Valves

Now Available in New Materials

WORKING PRESSURES—up to 150 pounds. Water, air, oil, or gas, 180°F. maximum temperature, depending on valve size and materials.

You asked for it—and now Crane gives you this outstanding Diaphragm Valve in a new wide choice of body, disc insert, and diaphragm materials—in unlined or lined patterns. Whichever is specified, Crane design gives you important advantages including—long diaphragm life . . . positive shut-off in case of diaphragm failure . . . less resistance to flow with minimum pressure drop . . . easy operation . . . simplified maintenance at lowest upkeep cost.

Full specification data is in your new Crane 53 Catalog—or ask your Crane Representative.

SCREWED ENDS, UNLINED Sizes ½ to 2 in.
Brass, Cast Iron, Aluminum, or 18-8 Mo body and disc. Furnished with neoprene, Buna N, and natural rubber diaphragm and disc insert.

FLANGED ENDS, UNLINED Sizes ½ to 6 in.
Cast Iron, Aluminum, or 18-8 Mo body and disc. Furnished with neoprene, Buna N, and natural rubber diaphragm and disc insert.

FLANGED ENDS, LINED Sizes 1 to 6 in.
Cast Iron body only. Lined with neoprene or hard natural rubber. Disc coated with neoprene or soft natural rubber.

Other body and disc materials, as well as linings, available on special order. Also sliding stem valves for automatic operators of all types.

CRANE VALVES

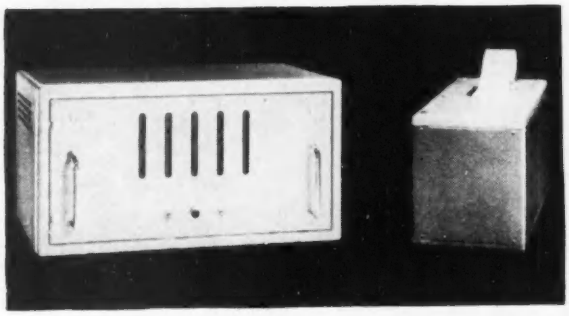
CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Digital Recorder Has Printed Readout

Used as a printed readout for a high-speed electronic counter, this digital recorder provides a direct means of permanently recording sequential count information in Arabic numeral form on a standard adding machine tape. It is designed to operate from electronic counters, Time Interval Meters, Events-Per-Unit-Time Meters, nuclear scalers, and other electronic totalizing devices at maximum cycling rate of one printout every 0.8 second.

This series 1550 digital recorder is composed of a read-out unit and a printing recorder. The first unit consists of a bank of readout decimal counting units essentially paralleling the totalizing function of the basic counting instrument from which they operate, and a selecting relay matrix to channel information from the counting circuit to the printing recorder. This second unit presents a sequence of total counts in direct reading digital form on a standard adding machine tape. The readout unit shown in the illustration is available in three, four, five and six bank units.



It has a recording and indicating capacity of 3, 4, 5, or 6 decades; the maximum cycling rates is one print-out every 0.8 seconds; the counting period is determined by the characteristics of the basic counting instrument.

Berkley Scientific Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

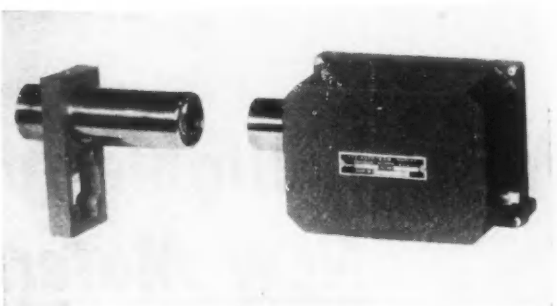
Photoelectric Unit For Plate Circuit Control

Actuation of electric counters and other devices directly in the plate circuit instead of through the conventional plate circuit relay is done by a new photoelectric unit called the Shadowswitch.

Elimination of the conventional relay offers two advantages: higher counting speeds are obtainable; the service life of counters is increased. For example, electric counters normally rated 600 CPM are being operated at 1000 CPM in the plate circuit. Also, counters having a normal life of 100 million counts when operated on a-c through a photoelectric relay have a normal life of 400 million counts when made for d-c and operated in the plate circuit.

The amplifier is pre-adjusted to maximum sensitivity; adjustments for specific applications are made with the light beam which can be focused for interruption by objects as small as $\frac{3}{16}$ in. in diameter. Even sharper focus is obtainable through use of an extra lens.

The photoamplifier has positive lock tube shields and rubber base tube sockets. The light beam is adjustable, and



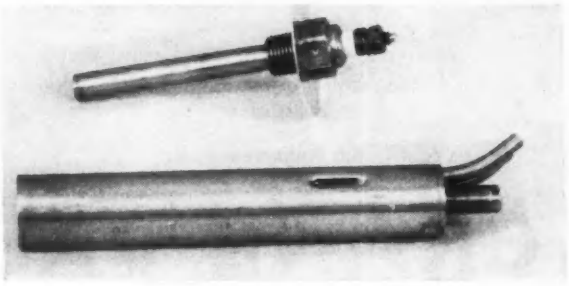
the amplifier and electric eye are combined in a case of cast aluminum. The light source is housed in a brass tube supported by an aluminum mounting block. Maximum output of the plate circuit is 110 volts, d-c.

The Autotron Co., Box 722-V, Danville, Ill.

Precision Control With Midget Thermostat

A redesigned midget Thermoswitch, having an outside diameter of only $\frac{1}{4}$-in., has been developed for precision temperature control or where overheat detection must be provided in solids, liquids or gases where space is at a premium. The midget thermostat is adjusted to any temperature set-point in the range from —50F, to 450F, and has a sensitivity of 0.1 F. Rated at one ampere at 48 v a-c or 32 v d-c, it is compared in the illustration to a standard $\frac{5}{8}$ in. dia. cartridge thermostat.

The midget switch is of the inverse compression type in which the contacts close with a temperature rise. It has such operating characteristics as: built-in temperature anticipation; fast reaction time; and high resistance to mechanical vibration and shock, and short heat transfer path.

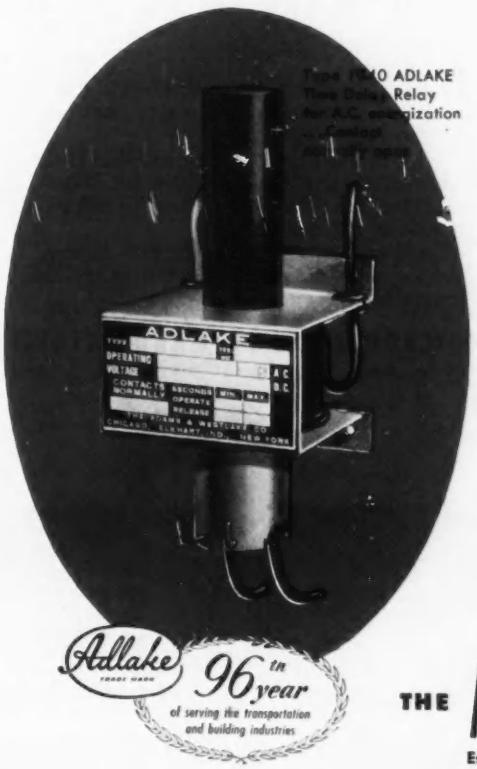


Fenwall Inc., Ashland, Mass.

CONTINUED ON PAGE 225

Why

are more and more industries specifying ADLAKE Mercury Relays for Timing and Control Functions?



...BECAUSE they are designed and built to meet the most exacting needs of industry! They've won their place by *proven dependability*—year in and year out—in jobs that conventional relays can do in an uncertain manner at best! For every ADLAKE relay is tested—and guaranteed—to meet specifications!

For Instance, ADLAKE Mercury Relays have proved their ability to stand up under the most adverse conditions of temperature and moisture. Their time delay characteristics are fixed and non-adjustable...normal line voltage fluctuations or ambient temperatures from —38.8° to 200° F. have no material effect on these characteristics.

Yes, in chick incubators or diesel generators...wherever sensitivity and dependability are required...ADLAKE Relays can always be counted on! Send for the ADLAKE Relay Catalog today... no obligation, of course. The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana.

EVERY ADLAKE RELAY GIVES YOU THESE PLUS FEATURES:

• HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation • SILENT AND CHATTERLESS • REQUIRES NO MAINTENANCE • ABSOLUTELY SAFE • MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking

...And every ADLAKE Relay is tested—*and guaranteed*—to meet specifications!

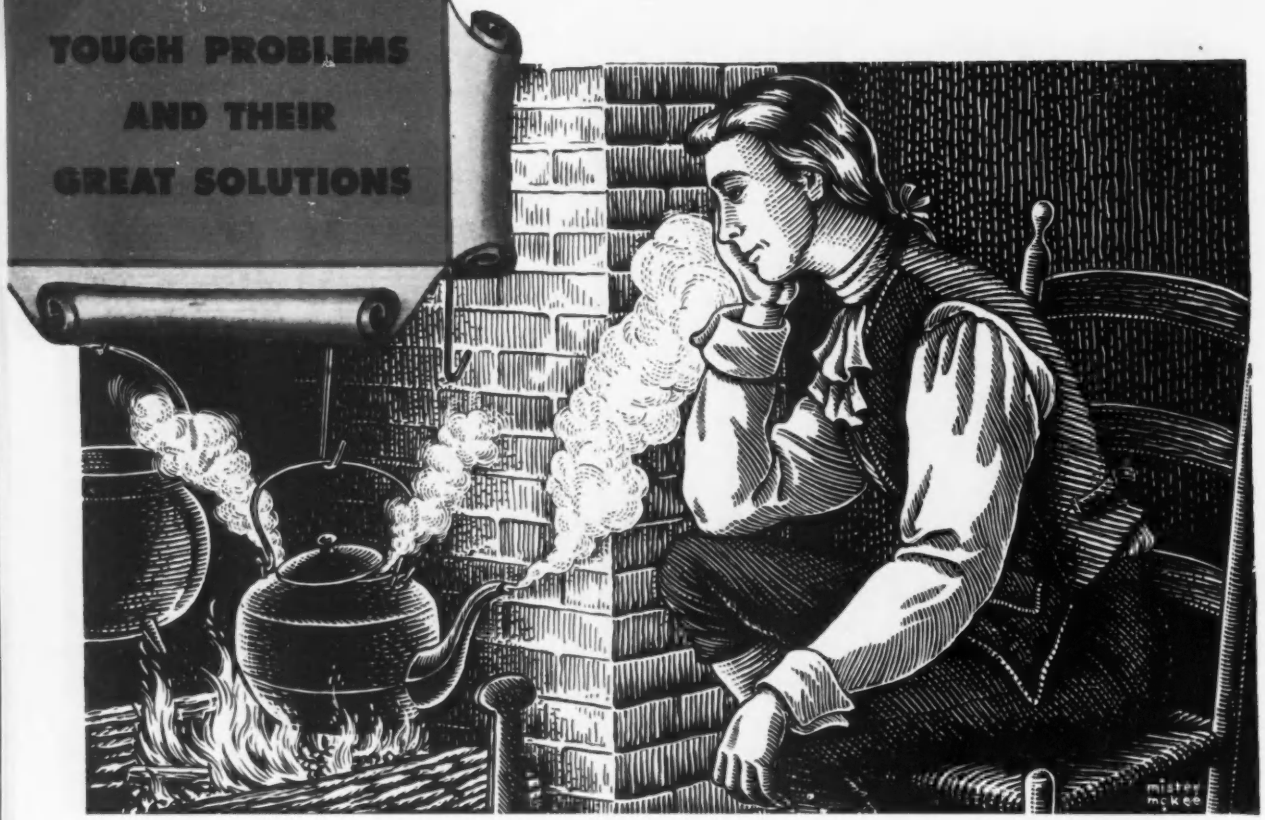
Adlake TRADE MARK 96th year of serving the transportation and building industries

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

TOUGH PROBLEMS AND THEIR GREAT SOLUTIONS



The Tea-Kettle that pulled a Train

"There's power in that steam," thought young Jim Watt, as he watched his kettle's dancing lid. "But how much is wasted!"

Eight years later, in 1765, as the 29-year-old inventor was walking of an afternoon in Glasgow Green, the solution came to him.

Watt condensed the steam in a vessel distinct from the cylinder, a basic idea that transformed the clumsy and wasteful steam engine of that period into so potent a prime mover that it made the locomotive possible.

It's great to have an idea. It's much more wonderful to make it work. That's where we come in.

Design engineers are constantly coming up with operating mechanisms that involve pliable parts. These parts must combine exactly the right physical characteristics with continued dependability even under extremely adverse conditions. It's a highly critical operational area.

Sirvene engineers have three great assets to offer you. The first is their unequalled experience in the highly specialized field of pliable parts. The second is their development of whatever Sirvene compound is best adapted to the specific problems involved. The third is quantity production of laboratory high quality, assuring exact compliance with specifications.

The time to let Sirvene engineers help you is while your new product is still on the drawing board. Given an important idea, you cannot afford to risk its invalidation by possible part failure.

The monograph "Engineering with Sirvene" belongs in your file and will be sent you free on request. Your correspondence is invited.

CHICAGO RAWHIDE MANUFACTURING CO.

1299 Elston Avenue SIRVENE DIVISION Chicago 22, Illinois

75 C/R

SIRVENE

SCIENTIFICALLY COMPOUNDED ELASTOMERS

sirvis
Mechanical Leather Products

Boots, diaphragms, packings and other products that give dependable service under difficult operating conditions.

PERFECT Oil Seals

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

Representatives in these Principal Cities

Boston • New York • Syracuse • Philadelphia • Pittsburgh
Cincinnati • Cleveland • Detroit • Peoria • Minneapolis
Kansas City • Houston • Los Angeles • San Francisco

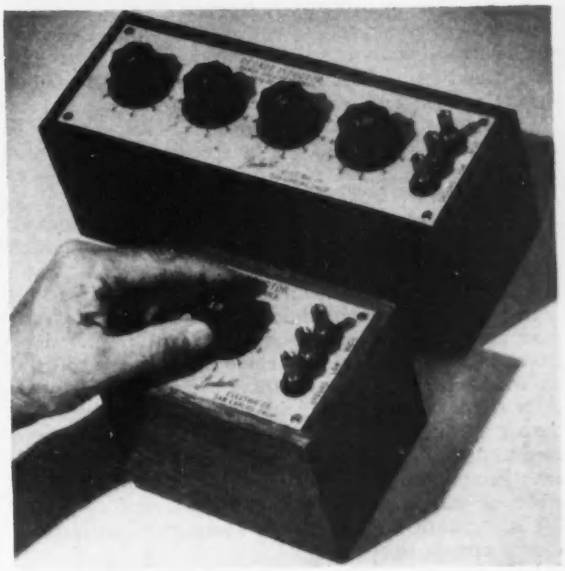
Four-Range Decade Inductor Units

Four Decade Inductors, available with inductance values guaranteed to within one percent, cover the ranges from 1 to 10 mH, 10 to 100 mH, 100 mH to 1H, and 1 to 10 H. All four units are also available as a single unit to cover the complete range from 1 mH to 10 H.

Moisture resistant impregnated inductors are wound on molybdenum permalloy toroidial cores for high-Q and low external pickup. Each decade has complete electrostatic shielding.

Specifications

TYPE	DE.01–1A	DE.1–1A	DE1.0–1A	DE10–1A	DE11.11–2A
Inductance range, millihenrys*	1–10	10–100	100–1,000	1,000–10,000	1–11,110
Inductance steps, millihenrys	1	10	100	1,000	1
Current carrying capacity, milliamperes, d-c**	600	60	6	0.6	0.6
Inductance tolerance, guaranteed per cent	1	1	1	1	1
Over-all dimensions, length-width-height, in.	6x4½x4¼	6x4½x4¼	6x4½x4¼	6x4½x4¼	12x4½x4¼



Lenkurt Electric Co., 1122 Country Rd., San Carlos, Calif.

Pressure Transmitter for Automatic Control Systems

A differential pressure primary element transmitter, for use in automatic control systems, covers a differential pressure range of 0-20 in. to 0-200 in. of water at static pressures up to 1500 psig. Known as the type D2T Automatic differential pressure transmitter, it is used in conjunction with the Autronic control system also developed by the manufacturer. The unit transmits an electric signal which is directly proportional to the variable being measured.

The manufacturer claims that since the control system is all-electronic, eliminating electric motors, slide wires, and contacting mechanisms, response is instantaneous.

The differential pressure transmitter has a corrosion-resistant stainless steel diaphragm. Small movements of the diaphragm are transmitted through a friction-free amplifying linkage to the movable core of the differential transformer which provides the 0.000 to 0.500-volt 60-cycle a-c signal output required for operation of other units in the System.

A feature of the Differential Pressure Transmitter is the anti-thrust pressure seat which transmits motion of the sensing diaphragm to the signal-generating differential transformer, and acts as a seal against high static pressures.

The unit uses a spring zero adjustment, a linkage-ratio adjustment for coarse span, and an electrical adjustment for fine span which does not affect the zero adjustment.

The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

THE SIZE RANGE OF A LINE OF seamless light-wall tubing has been increased from a 1¼ in. O.D. max., to 2 1/16 in. O.D. maximum. The large diameter tubing is furnished in three stainless types: AISI type 304, 321, and 347, and in Monel metal, and made in three tempers: fully annealed; half-hard drawn; and full-hard drawn. Length range is from 5 to 22 feet. Minimum and max. wall thickness for sizes up to ⅞ in. O.D. are 0.006 in. and 0.035 in. respectively. For 1½ to 2 1/16 in. O.D. min., and max. wall thickness is 0.010 in. and 0.025 inch. Wall thickness is ±0.010 in. on all sizes. Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.

CONTINUED ON PAGE 226

Long Life, Heavy-Duty Contactors

A new line of heavy-duty, single-pole d-c contactors, type 260 for use on rolling mill controls, mill auxiliaries, cranes, hoists, and related equipment is built for long contact and arc chute life, and is designed for fast routine inspections and easy replacement of wearing parts.

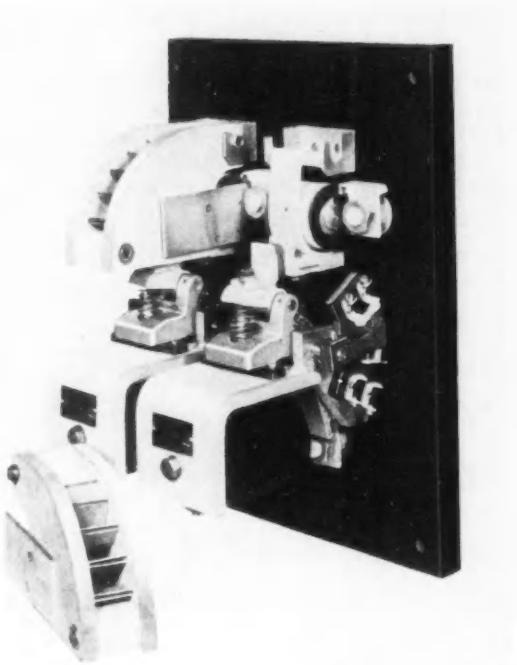
Contact life is extended by a principle of arc interruption which reduces contact burning by speeding arc extinction. To prolong contact life, main contacts are made of heavy forged copper having high material density and uniformity.

The initial contact is made on the tips of the contacts. Wiping and scuffing are minimized by the rolling action of the follow-through. Arcs are handled on the tips, and normal running current is carried on the contact heels.

Fast arc extinction and quick current interruption result from arc chutes which stretch, cut, and cool the arc. First the arc is formed into the arc chute by a blowout coil and an arc runner. As the arc strikes the loop end of each chute segment, a magnetic field is established which forces the arc upward and toward the center of the chute. Both thermal convection and magnetic action stretch and cool the arc. Because the arc is of short duration and kept in the center of the arc chute, arc chute life as well as contact life is increased. The arc chute walls are of arc-resistant abestos cement compound.

Mechanical interlocks consisting of horizontal phenolic bars pivoted at the center are available for pairs of contactors. The contactor is available with or without electrical auxiliary interlocks, in ratings of 600, 300, and 150 amp. at 600 V maximum, covering most control needs.

Two of the 150 amp contactors, normally open with auxiliary switch are shown in the illustration.



Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

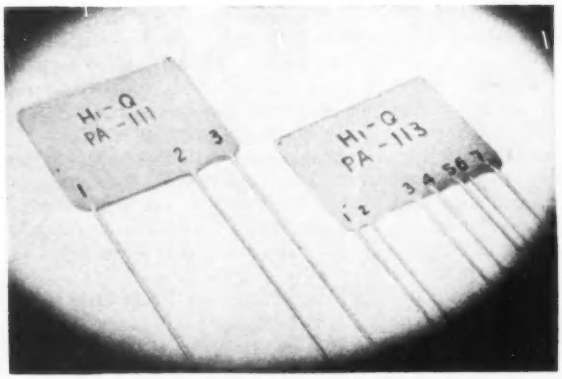
Plate Assemblies for Miniaturization

Compact and convenient combinations of ceramic capacitors, resistors and printed conductors in units called plate assemblies, are now being used with advantages for dependable miniaturization.

Two distinct methods of producing such plate assemblies are possible: (1) by using the high dielectric base which is also used for the dielectric of the capacitors; and (2) by using a separate base plate and attaching to it the individual dielectric ceramic capacitors/resistors. The single plate is said to permit a more compact and simplified sub-assembly, while the latter form gives advantages in the more complex circuits, and results in lower distributed capacitance.

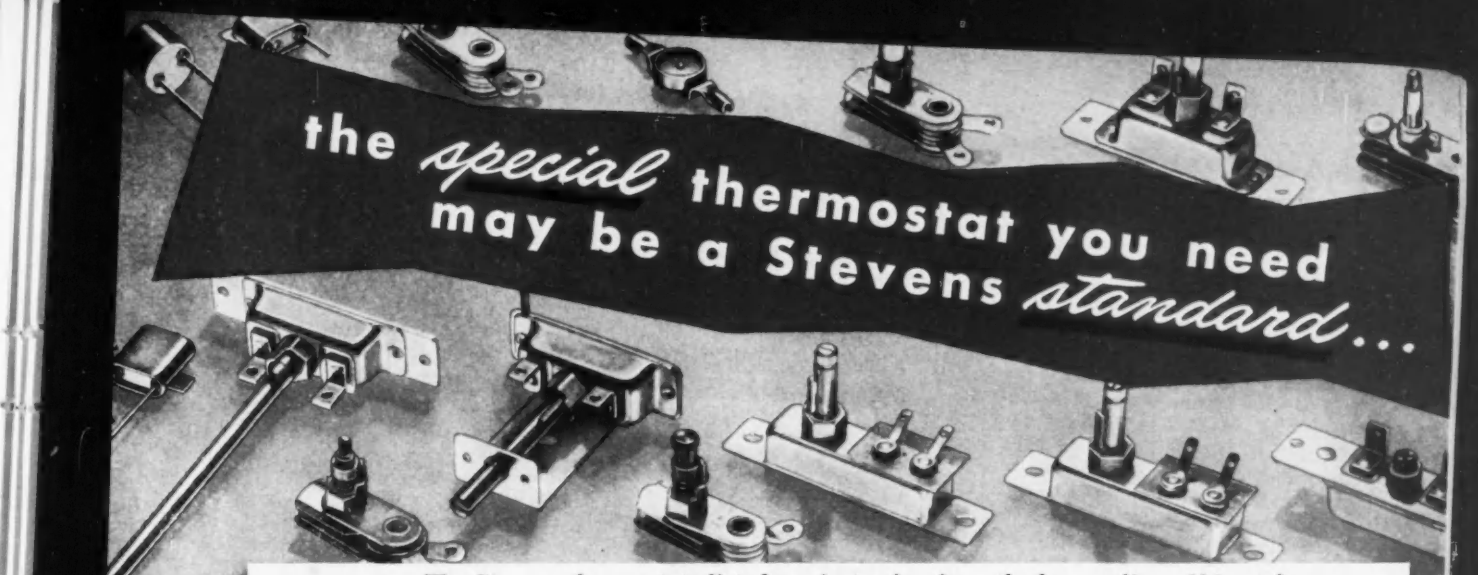
These plate assemblies are versatile electronic components. The manufacturers claim that number and combination of capacitors/resistors which can be incorporated in a single unit is almost endless, or limited only by the K of the material and the physical size. These units aid in dependable miniaturization and simplify assembly by reducing the number of soldered leads. The unit sizes are $1\frac{1}{16}$ in. long by $\frac{9}{16}$ in. or $\frac{13}{16}$ in. wide and $\frac{5}{32}$ in. thick.

Among the generally used plate assemblies are: vertical integrators; vertical integrator and coupler units; audio plate-grid couplers; second detector and audio amplifier couplers; pentode second detector and audio amplifier units; and pentode plate coupler and screen supply units. The PA-113 network requires only seven leads instead of the 16 necessary in the use of individual components, saving soldering time, and reducing parts stocking.



Hi-Q Div., Aervox Corp., Olean, N. Y.

CONTINUED ON PAGE 228



the *special* thermostat you need may be a Stevens *standard*...

● The Stevens thermostats listed are just a few from the largest line of bimetal thermostats in the industry. So even if you have an unusual problem in thermostat design, check with Stevens first. Chances are a *standard* Stevens thermostat will satisfy all your performance, size, cost and delivery problems.

FEATURES	TYPE S	TYPE SA	TYPE R	TYPE W	TYPE M	TYPE C
STYLES						
Non-Adjustable	Yes	Yes	Yes	Yes	Yes	Yes
Adjustable	Yes	Yes	Yes	Yes	No	No
Manual Reset	No	Yes	No	No	No	No
Single Pole Double Throw	Yes	Yes	No	No	No	No
Positive Acting	Yes	—	Yes	—	—	Yes
Snap Acting	No	Yes	No	Yes	Yes	No
Open	Yes	Yes	No	No	Yes	Yes
Enclosed	No	No	Yes	Yes	Yes	Yes
Hermetically Sealed	Yes	Yes	Yes	Yes	Yes	Yes
ADJUSTABLE TEMPERATURE RANGE, Maximum	650° F.	650° F.	650° F.	650° F.	—	—
OPERATING TEMPERATURE, Maximum	650° F.	650° F.	650° F.	650° F.	650° F.	400° F.
DIFFERENTIAL, as measured on bimetal						
Maximum	App. 15° F.	150° F.	App. 15° F.	50° F.	600° F.	App. 5° F.
Minimum	App. 5° F.	10° F.	App. 5° F.	5° F.	8° F.	App. 5° F.
CALIBRATING LIMITS						
Standard	±10°F	±10°F	±10°F	±10°F	±5°F	±5°F
Special	±5°F	±5°F	±5°F	±5°F	±3°F	±3°F
RATING (Non-Inductive Load)						
115 Volts a.c.	15 amps.	25 amps.	15 amps.	12 amps.	8 amps.	5 amps.
230 Volts a.c.	10 amps.	15 amps.	10 amps.	8 amps.	4 amps.	2 amps.
28 Volts d.c.	15 amps.	25 amps.	15 amps.	12 amps.	*	5 amps.
ANGLE OF ROTATION, Maximum	300°	300°	300°	300°	—	—
MOUNTING	Single Stud	Single Stud	See Bulletin F-2003	See Bulletin L-4079	See Bulletin F-2009	See Bulletin F-2008
VIBRATION RESISTANCE	Fair	Good	Fair	Good	Good	Good
CORROSION RESISTANCE						
Standard	Good	Good	Good	Good	Good	Good
Hermetically Sealed	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
HIGH ALTITUDE PERFORMANCE	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
SIZE	See Bulletin F-2006	See Bulletin L-4144	See Bulletin F-2003	See Bulletin L-4079	See Bulletin F-2009	See Bulletin F-2008

*Will interrupt 150 amps. 12 volts d.c.

MARK YOUR PRINTS--STEVENS THERMOSTATS ~~OR~~ EQUAL

Note: Thermostats shown approximately half size.

have no

STEVENS

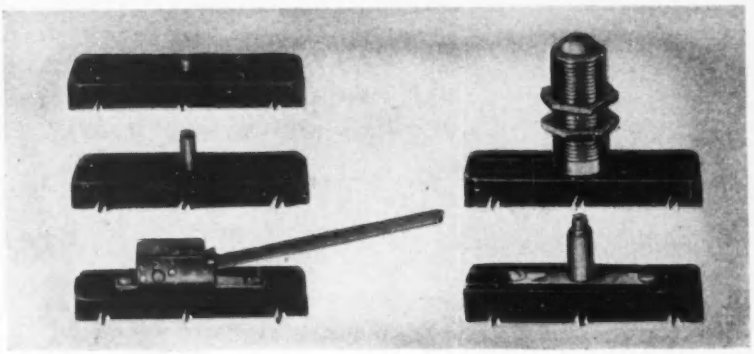
manufacturing company, inc.

MANSFIELD, OHIO

Actuators for Long Life Limit Switch

The long life "du op" limit switch, now available with four new types of actuators is vibration resistant, and has fast switching action with a minimum of bounce.

The type DU-O is operated by a heavy duty $\frac{1}{8}$ in. dia nylon plunger; type DU-L is a sensitive leaf actuator, and may be set to any of three leverage positions; type DU-B may be actuated from the side or at any lesser angle by means of a ball serving as actuator; type DU-E provides for plunger over-travel of up to 0.093 in. and consists of a stainless steel plunger. The "du-op" switch is rated at 20 amp, 125 volts a-c, noninductive.



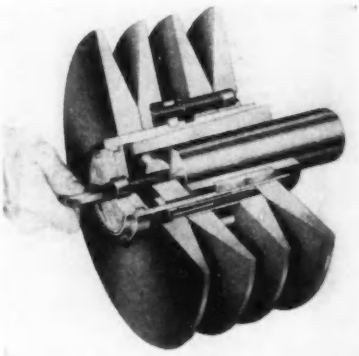
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

Variable Speed Drive Easily Adjusted

Components of a new variable speed drive are: (1) a variable pitch motor sheave; (2) a set of wide range belts; (3) a companion sheave; (4) a slide motor base. Using the top or-lock principle in the bushings for both sheaves is said to increase the speed with which speed changes can be made. The sheaves occupy little space on the shaft and the assembly locks on the motor shaft as a unit by a set screw.

The pitch is changed by means of a one-point adjustment. The single adjusting screw may be located at either end of the sheave although normally the sheave is assembled with the adjusting point located on the motor side. The pitch diameter can be set and cylinder speeds held to close limits.

The slide motor base permits changes in center distances to preserve proper belt tension as the variable pitch sheave is adjusted for different speeds. A full range of centers is possible by turning one screw. It is of flush design, and is available in a range of sizes for NEMA frame motors.



Dodge Mfg., Co., Mishawaka, Ind.

AVOIDING BRUSHES completely by use of a permanent magnet construction, the Nobrush electric generator has such advanages as: immunity to damage by moisture, overload, or short-circuit; reduction in size and weight; almost no maintenance; and elimination of radio interference. Used on portable power units, marine craft or vehicles, and high frequency power tools. The Georator Corp., Arlington 9, Va.

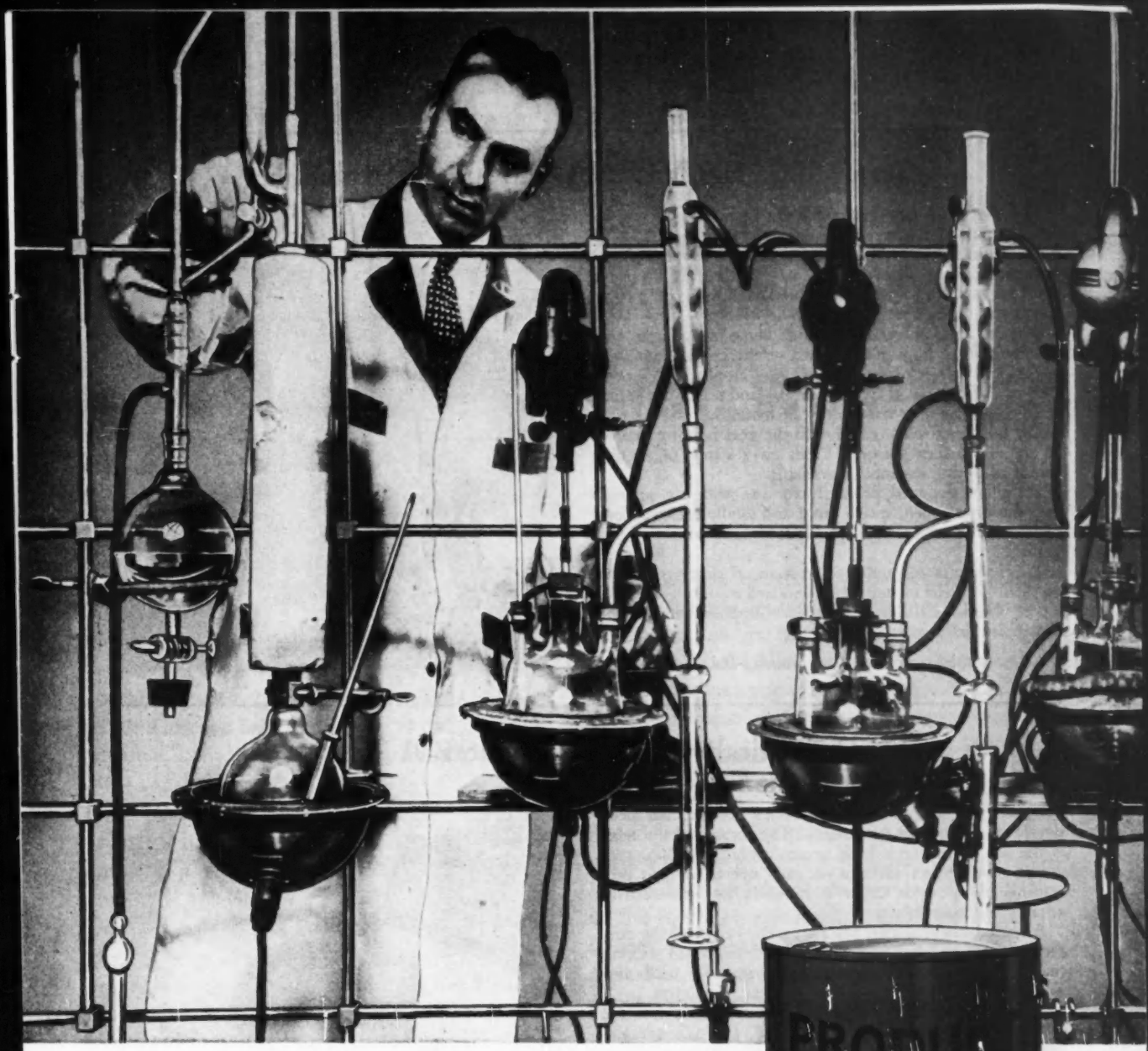
THE TYPE M1552 HIGH SPEED BINARY COUNTER is used for all types of counting and frequency division to rates in excess of 3 megacycles per second. The counter is a small plug-in unit measuring $1\frac{1}{4}$ in. in dia. and weighs 3.2 ounces. Input is 75 V negative pulses with a rise time of 0.2 microseconds; output is 125 V, with a rise time of 0.2 microseconds. The Walkirt Co., Inglewood, Cal.

DESIGNATED THE UNIVERSAL T-54, a new type contact wheel is available with spare rubber tires to eliminate replacing the entire contact wheel after continuous use. The wheel consists of a rubber tire vulcanized on a steel frame or rim, and a split, universal hub. Tires are available in standard face widths of one in. to 6 inches. Durometers range from 10 to 90 in either plain or slotted surfaces. Chicago Rubber Co., 2620 Clybourn Ave., Chicago, Ill.

A SPECIAL TYPE OF FLEXIBLE, high-pressure industrial rubber hose is built to withstand working pressures as high as 5,500 psi, and temperatures from —40 to +200 F. Standard sizes range from $\frac{3}{16}$ in. to 2 in. for hydraulic control hose. The hose will carry various types of gases or fluids, and will not rust or corrode. Lee Rubber & Tire Corp., Republic Rubber Div., Youngstown, Ohio.

AN IMPROVED TACHOGRAPH that analyzes the vehicle operation and movement has increased illumination of the clock face speedometer and odometer for better vision, and an easier setting warning light to conform with prevailing speed limits. The tachograph chart is inserted on rectangular studs, and a million-mile odometer accurately records total mileage of the vehicle. Wagner Electric Co., 6400 Plymouth Ave., St. Louis 14, Mo.

CONTINUED ON PAGE 230



RECOGNIZE THIS MAN?

Probably not . . . but he works *for you*—the Glidden Product Finishes customer—together with 249 other highly trained technicians and chemists, located in 23 Glidden laboratories throughout the United States and Canada. His job: to make sure that you get a finish that's custom-tailored to the exact requirements of your product—and your finishing system.

We think he's a mighty good reason why it pays to do business with Glidden.

THE GLIDDEN COMPANY
INDUSTRIAL FINISHES DIVISION
11005 MADISON AVE. • CLEVELAND 2, OHIO

SALES OFFICES AND FACTORIES: San Francisco, Chicago (Nubian Division—1855 North LeClaire Avenue), Minneapolis, New Orleans, St. Louis, Cleveland, Reading and Toronto.

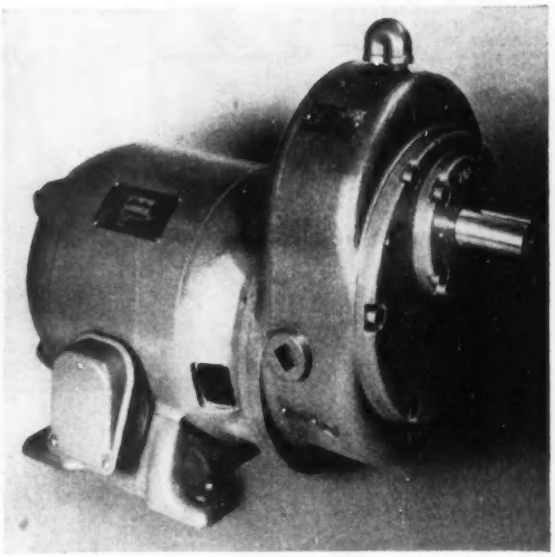
Gear Motor Has Variety Of Mounting Assemblies

Six sizes of a new gearmotor are in ratings of one to 30 hp with standard gear ratios ranging from 2.24 to 4.17:1, and speeds of 780 to 420 rpm. It is a type B single reduction unit of the overhung gearhead construction using the foot mounting of standard NEMA frame size motors to support the drive.

Typical applications are the side entry of agitators and mixers, and for light duty coupled service applications such as fans and pumps. The gearmotors are supplied for various methods of horizontal type mounting, and are available for ceiling, and right or left hand wall mounting (with shafts in the horizontal plane) and with the gear housing located in any of the four positions. This gives a total of 16 different mounting assemblies available.

Although designed primarily for use with a-c squirrel cage motors of open, splash proof and totally enclosed construction, they are also adaptable to wound rotor and d-c motors.

Lubrication is accomplished with an oil slinger mounted on the input shaft of units with standard mounting arrangements. Mechanical type oil seals are supplied between the motor and the gear case.



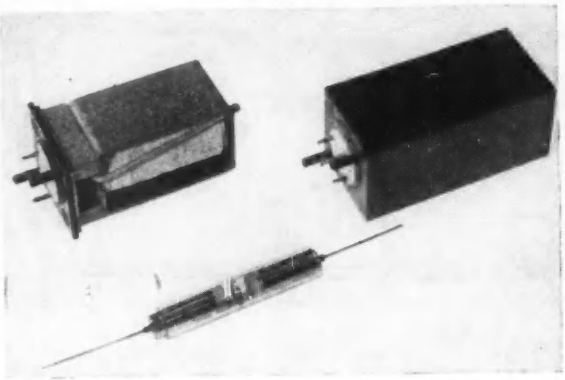
Westinghouse Electric Corp., Gearing Div., Pittsburgh, Pa.

Hermetically Sealed Magnetic Ball Relay

A shock-proof, hermetically sealed relay, capable of operating at high speeds, over 100 cycles per sec, has been developed for use on d-c circuits. The feature of the relay is the use of magnetic balls as the contact medium, providing new contact surfaces on each operation, and preventing mis-operation under vibration in locations such as aircraft and automobiles.

A special non-magnetic plating on the balls and the pole pieces is said to give a long life contact, and avoid sticking caused by current interruption. The material used also prevents contact holding due to residual magnetism.

The pole pieces are insulated from each other and are the terminals of the circuit to be closed. Upon de-energizing, the balls release and fall to one side of the chamber and interrupt the circuit. The manufacturers claim that the proportionals of pole pieces, chamber and number of balls will not permit bridging between the terminals even with shaking of the relay, regardless of its attitude.



Magnex Corp., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

High Speed Discharge Ceramic Capacitor

Having the characteristics of 30 ft of solid coaxial transmission cable, a new type ultra-high speed discharge capacitor is 2 in. in dia and 6¼ in. long. When used in the same manner as the coaxial cable, charged to 10,000 v and discharged across a spark gap, the capacitor improves light intensity 900 times.

The capacitor tube is made of hi-K ceramic (K-2000), which is silvered inside and out. It has a capacitance rating of at least 0.024 mfd, (24,000 mmf) and immersed in transformer oil is rated at a working voltage of 20,000 volts d-c.

Designated DA778-001, the unit has a decay time, peak to peak, of 2×10^{-7} sec, a rise time, zero to peak, of 2×10^{-7} sec, and 50 percent of peak limits occur in a period of 1.8×10^{-7} second. Leakage resistance is in excess of 10,000 megohms, and dielectric strength is about 35 v per mil.

More information on this and other types of ceramic capacitors may be obtained from the manufacturer.

Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

CONTINUED ON PAGE 232

PROSPERITY IN THE USA: How Wealthy Are We?

Again, how prosperous *are* the people of the United States?

This is the third of a series of messages devoted to this crucially important and much-debated question. The first two messages dealt with what has been happening to our national income, both in terms of its growth and how it is divided among individuals.

This third message deals with what has been happening to the resources—factories, farms, mines, and equipment of all kinds—out of which income is created. It deals with what economists call our wealth.

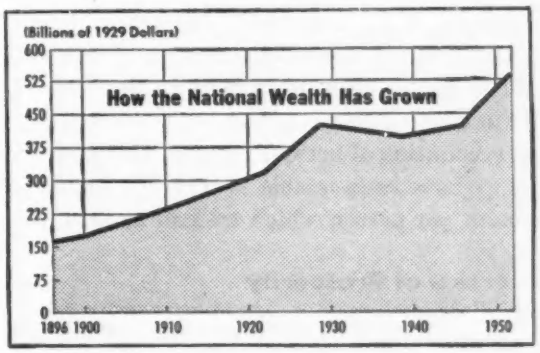
It is possible for a nation to enjoy apparent prosperity for a time by rapidly exhausting its resources. But to sustain prosperity over the long pull a nation must see that its wealth is not dissipated. Hence what is happening to our wealth now is a harbinger of what is going to happen to our prosperity later on.

How Wealth is Measured

It is often asserted that the most vital element in a nation's wealth is its people. There is a lot in this idea. For example, the full value of a country's hospital and surgical equipment depends on its physicians and their skill in handling the equipment.

However, no one has ever devised a satisfactory way to put a value on human beings. So people are omitted from calculations of national wealth. So, too, is military equipment. It is regarded as basically destructive and hence not a real addition to wealth. Otherwise, the wealth of a nation is calculated in terms of the dollar value of its physical resources.

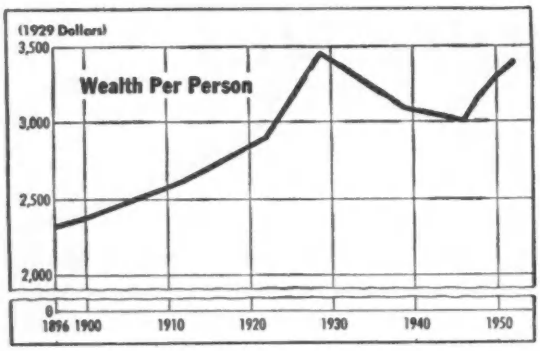
The following chart shows the wealth of the U.S.A. at various intervals during the past 50 years. For the period through 1948 the figures come from a pioneering study by Raymond Goldsmith of the National Bureau of Economic Research, which is widely regarded as the foremost organization in its field. The figures since 1948 are estimated. To remove the effect of price changes, all of the wealth figures are calculated in 1929 prices.



From this chart one fact stands out clearly. It is that since 1929 our national wealth has not been increasing as steadily as it did during

earlier periods. Indeed, in 1946 our total national wealth was actually less than it was in 1929. Only in the last six years have we been able to make any consistent additions.

Even these gains are less impressive when the growth in our population is taken into account, as illustrated by the following chart.



This chart makes it clear that when the nation's wealth is divided by the population, we are slightly worse off per person today than we were in 1929. This is the case in spite of the large additions to our national wealth since 1946.

Depression and war are the two principal reasons we have made no progress in increasing our wealth per person since the 1920s. The depression brought mass unemployment and greatly reduced production which ruled out any increase in wealth. During World War II and again during the post-Korean mobilization program, U.S. production has reached new peaks. But a considerable portion of this record breaking output has been in the form of military equipment, which is not included in an accounting of national wealth. Consequently, we have been unable to regain the level of wealth per person which we had in 1929.

A Brake of Prosperity

What does this failure to raise our wealth per person mean? It means that we have fewer resources with which to create income for each individual. It means that we have made no progress in the crucial task of assuring future increases in prosperity.

As the second editorial in this series demonstrated, we have gone so far in equalizing individual incomes that "the possibilities of increasing the income of the rest of the people by 'soaking the rich' have largely disappeared." From now on the only promising way to increase our individual incomes is to increase our national earning power.

During the past four years it has taken about $3.60 of national wealth to yield $1 of income after taxes. This is a low figure for the wealth needed. Prior to World War II there were long periods when it took at least $5 of national wealth to produce $1 of national income. The experts in this field are by no means certain that it will not again take $5 rather than $3.60 of wealth to increase income by $1.

But let us assume that $3.60 of wealth will suffice to provide $1 of income in the years ahead. If by 1960—seven years from now—the income of the average American is to be increased from about $1490, where it stands at present, to $2000, we must add $310 billion to the national wealth. This is nearly three times as much as we have added to our wealth since the end of World War II, seven years ago.

Because we have made large additions to our productive equipment in recent years, fears are frequently expressed that we shall soon be plagued by an excess of such equipment. But the facts about our national wealth do not support this conclusion. They indicate that we still have ahead of us a tremendous job of increasing our resources if the American standard of living is again to resume the steady climb which was interrupted by depression and war.

McGraw-Hill Publishing Company, Inc.

NEW CATALOGS AND BULLETINS

A Reader Service To Help Keep You Up-to-Date

(1) FLEXIBLE TUBING—Flexible Tubing Corp. Catalog C2-3. Describes a line of flexible tubing in diameters from less than 1 to 30 inches. Made of fabric supported rubber or plastic wound on helical spring wire coils. Is non-collapsible, and non-kinkable. Allows up to 180 deg. turns.

(2) AUTOMATIC VOLTAGE STABILIZERS—General Electric Co. Booklet GEA-5754, 12pp. Contains photographs, diagrams, and operating curves on automatic voltage stabilizing units ranging from 15 to 5,000 volt-amperes. Gives operation principles and construction, and gives complete specifications. Also describes the causes and effects of voltage variations, and lists typical applications for stabilizers.

(3) FLEXIBLE METAL HOSE—The American Brass Co., Catalog CC-400, 16 pp. Shows a wide range of available alloys and sizes, suggested applications, and furnishes data on the hose and fittings. Engineering information also included. Made in types: Seamless, and strip wound. Has illustration of each type.

(4) DIRECT WRITING RECORDERS—The Sanborn Co. Booklet 23M, 16 pp. Entitled "7 Advantages of Direct-Writing Recorders for Industrial Users," it illustrates and describes a line of equipment for the study and recording of a variety of electrical and mechanical phenomena.

(5) THREAD PITCH DIAMETER TOLERANCE CHART — Security Locknut Corp. gives tolerances for coarse and fine threads from $\frac{5}{16}$-24 up to $2\frac{3}{4}$-8, and from $\frac{1}{4}$-16 up to $2\frac{3}{4}$-4 in classes 2, 2-A, 2-B, 3, 3-A, and 3B. Based on screw thread standards for Federal Services Handbook, Military Spec. MIL-S-7742, and American Screw Threads ASAB1.

(6) DIE-LESS DUPLICATING — O'neil-Irwin Mfg. Co. Catalog 52-19, 34 pp. Describes a line of power equipment for long run production operations. Covers: benders; hydra-power bender; rod and power parter; power shear; notcher; punch press; power matcher and punch press; standard, finger, and radius brake; and roller.

(7) RECORDING & INDICATING TACHOMETERS—The Bristol Co. Bulletin S1402, 20 pp. A line of recording and indicating electric tachometers for measuring speed of rotation or travel, processing time, speed ratios, sum of difference of speeds, and average of speeds. Engineering specifications and specifications on magnetos and types of magneto drives are given.

(8) CHANGE SPEED UNIT—Philadelphia Gear Works, Inc. Bulletin CSU-52, 24 pp. With many illustrations, cross-section views, and engineering diagrams, it contains complete specifications of all the change speed units. Points covered are: procedure for selecting unit; table of load characteristics, service factors; dimensions of units; hp ratings; overhung load capacity; parts lists; and special arrangements of units.

(9) PACKINGS—Greene, Tweed & Co. Catalog PC-102, 20 pp. Covering all types of the Palmetto packings, the booklet includes details on: self-lubricating, molded, and sheet packings, plus information on a new type Teflon packing. Also has photographs, diagrams, cutaway views, and an overall packing application chart.

(10) RECTIFIER STACKS — General Electric Co. Booklet GEA-5699A, 8 pp. Complete with charts, graphs, and tables illustrating the characteristics, manufacture, circuit design, and application of copper-oxide rectifiers. Tables give ratings of; bridge; single phase full wave midtop; and three phase full wave bridge cells.

(11) POWER CLEANING UNIT—Kelite Products, Inc. Bulletin 125, 4 pp. Describes a steam cleaning machine designed for heavy duty, and having a rated steam capacity of 200 gal. per hour. Also delivers 1,000 gal. of hot or cold water per hour at 500 psi. Available in trailer mounted portable units and stationary models.

(12) ELECTRONIC COMPONENTS — Centralab, Catalog 28, 32 pp. Covers a complete line of volume controls; switches; capacitors; printed electronic circuits; and steatite insulators. Each topic has illustrations, engineering diagrams, curves, and complete specifications on the various models available.

(13) MAGNET SEPARATOR — S. G. Frantz Co. Inc. Bulletin 82, 6 pp. Complete information on the Ferrofilter permanent magnet separator, a unit designed to remove ferrous particles from circulating lubricating system; hydraulic oil lines; and from coolant systems. Has many illustrations and cross-section views.

(14) HYDROFORMING—Cincinnati Milling Machine Co. Booklet M-1759, 16 pp. Illustrations show each step in the process of Hydroforming, a method of drawing various shapes in all kinds of sheet metal with fewer operations. Each operation is explained. Discusses the tooling; operating cycle; and applications.

(15) CHEMLON PACKING—Crane Packing Co. Bulletin T-102, 12pp. Describes a line of products made from Teflon, a chemically inert plastic having a wide range of working temperatures. Used as a packing; as a gasket; for electronic insulation; and for non-stick uses. Specifications given for each product.

(16) PRECISION INVESTMENT CASTINGS—Casting Engineers, Inc. Bulletin 17, 4 pp. Illustrates a variety of parts of complicated design made by investment casting. A data sheet discusses the tolerances possible; the design of the parts; the alloys used, and the tooling.

(17) MINERAL INSULATED WIRING—General Cable Corp. Booklet, 24 pp. Entitled, "Safety Mineral Insulated Wiring

HOW TO ORDER—To request more information on any advertised item, jot down the page number of the ad and the initials of the advertiser. For new bulletins, circle the numbers.

Product Engineering Not good after 4/1/53

Please send complete information about the products advertised on the following pages:
(Use initial of company if more than one advertisement appears on the page)

....

....

....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Name..... Title .....

Company.....

Address..... 2/53

Product Engineering—A McGraw-Hill Publication

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
Product Engineering
330 West 42nd Street
New York 36, N. Y.

Sytem", it contains a complete history and an explanation of its advantages and applications. Photos of installations and complete specifications are included.

(18) SPECIFYING SURFACE ROUGHNESS—Micrometrical Mfg. Co. Bulletin L21, 4 pp. Entitled, "How to Specify Surface Roughness, and Why," it explains the term "surface roughness as applied to machined and finished surfaces, and describes the practical advantages of surface roughness specification.

(19) ALUMINUM MILL PRODUCTS—Reynolds Metals Co. Booklet, 12 pp. It gives the advantages of wrought aluminum alloys, and details the various product forms, finishes, alloys, tempers, and sizes that are available. Casting alloys are also included. Also has an alloy selection guide as well as information on fabricating and finishing.

(20) ALLOY STEEL PRODUCTS—Stroh Process Steel Co. Catalog, 14 pp. Included are pages on cast gears, bevel gears, mill pinions, spindles, coupling boxes, flanged crab couplers, sprockets, sheaves, racks, and pinions. Also has a comparison between the characteristics of Stroh 20 deg. involute teeth gearing and standard 15 deg. involute teeth gearing.

(21) THERMOPLASTIC EXTRUSIONS—Anchor Plastics Co. Booklet, 44 pp. Discusses forms and shapes of extruded plastics and a general summary as to how thermoplastics may be used by industry. A properties chart is also included.

(22) FORCE FEED LUBRICATORS—Hills-McCanna Co. Catalog L-52, 16 pp. Details on the open and enclosed type lubricators, available in capacities from 2 pints to 32 pints with 1 to 24 feeds per unit. Has large colored cutaway illustration, cross-section views and complete specifications.

(23) METAL STAMPING PRODUCTS—The Crosby Co. Booklet, 24 pp. Explains and illustrates methods of improving products, reducing the cost, and extending service life. Has analyses of thirteen stamped parts and fabricated assemblies as examples.

(24) ELECTRICAL LAMINATIONS—Thomas & Skinner Steel Products Co. Bulletin L-752, 24 pp. Gives materials, specifications, applications, test results, and size drawings of special and standard shapes of a line of electrical laminations, and the special "oriented" steel used in their manufacture.

(25) MATERIALS HANDLING EQUIPMENT—The Caster & Floor Truck Mfrs. Association Handbook, 48 pp. Information on how to select and use the manual materials handling equipment you need. Has a section on industrial wheels; casters; two wheel hand trucks; indutrial platform trucks and trailers; and pallets and skids. Members of the association are listed.

(26) ELECTRICAL RESISTANCE INSTRUMENTS—Tech Laboratories. Catalog, 38 pp. Specifications and other data on a line of precision electrical resistance instruments and electronic devices. Covered are: attenuators; potentiometers; portable gain set; decade units; viscosity meter; automatic timer megohmbridge; decade boxes; and others.

(27) PHOTOCOPYING DEVICE—American Photocopy Equipment Co., Booklet, 12 pp. With illustrations showing the operation, the principle of automatic developing and fixing is described. Measuring 21 in. long by 8 in. wide and 5 in. high, the unit produces a copy in less than 30 sec., and requires no dark room.

(28) RECIPROCATING ROTARY POWER—The Bonnot Co. Bulletin 21, 12 pp. Describes the Hydromotor, a hydraulic actuator that provides high torque valves through reciprocating rotary power. Diagrams show schematic applications. Several pages of engineering data on the single and double vane models. Also lists operating features and applications.

(29) GEAR CHECKING — Illinois Tool Works, Booklet AD-21, 16 pp. Shows apparatus, set ups, and testing for runout and side wobble, a diagram of an angular velocity test under load and chart, a worm gear rolling fixture, and a device for runout and size checking.

(30) VIBRATION METER—Consolidated Engineering Corp. Bulletin CEC-1505B, 4 pp. Shows the 1-110B vibration meter, for giving direct readings of both linear and torsional velocity and displacement, permitting easy calculation of the vibrational characteristics of machines. Can be coupled to recording oscillographs and oscilloscopes.

(31) SELF LOCKING NUTS—Standard Pressed Steel Co. Catalog, 24 pp. Has complete specifications on a wide variety of locknuts. Sizes, fits, part numbers, dimensions, tensile values, and materials are listed. May be used in temperatures up to 750F. Also included are data on external and internal wrenching nuts and clinch type locknuts. Illustrations of all types.

(32) STANDARD BORE COUPLINGS—Cone-Drive Gears, Bulletin CDC-52, 4 pp. Tables list capacities, specifications and ordering information for flexible couplings in 22 standard bore sizes from ¾ in. to 6½ in. For applications on worm shafts, gear shafts, and electric motor shafts. Illustrations show exploded views and assembly and disassembly procedures.

(33) MICA DIELECTRIC CAPACITORS—The Sprague Electric Co. Catalog 31, 32 pp. Comprehensive data on a line of transmitter type mica dielectric capacitors conforming with Joint Army-Navy specification JAN-C-5. Has illustrations, engineering drawings, and technical characteristics of each unit.

(34) PNEUMATIC CONTROLLER — Fischer & Porter Co. Catalog C-50, 20 pp. Data on the P-4 Pneumatrol pneumatic controller for rate of flow, differential pressure, liquid level, viscosity, pressure, and temperature applications. Available in: on-off; narrow band proportional; and wide band proportional control.

(35) NATURAL RUBBER PRODUCTS—Linatex Corp. of America, Bulletin L-101, 4 pp. Describes Linatex, a special form of natural rubber. Produced in sheet form at thicknesses of 1/32 in. to ½ in. Completely resistant to moisture, and has good resistance to low temperatures, abrasion, corrosion, and vibration.

(36) DOUBLE-END BOOSTER PUMPS—Thompson Products, Inc., Bulletin AD-152, 4 pp. Information on a double-end type fuel booster pump designed to deliver vapor-free fuel to the aircraft engine under all conditions. Also may be used for priming the engine and transferring fuel. Has illustrations and specifications.

(37) LEAK-PROOF PUMP SEAL—Bell & Gossett Co. Booklet ET-452, 14 pp. Has selection tables, and construction features of a leak-proof mechanical seal for use in centrifugal pumps. Made of a composition of materials, it is wear-proof, corrosion resitant, and is self-lubricating.

(Continued on page 254)

HOW TO ORDER—To request more information on any advertised item, jot down the page number of the ad and the initials of the advertiser. For new bulletins, circle the numbers.

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
Product Engineering
330 West 42nd Street
New York 36, N. Y.

Product Engineering Not good after 4/1/53

Please send complete information about the products advertised on the following pages:
(Use initial of company if more than one advertisement appears on the page)

....

....

....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

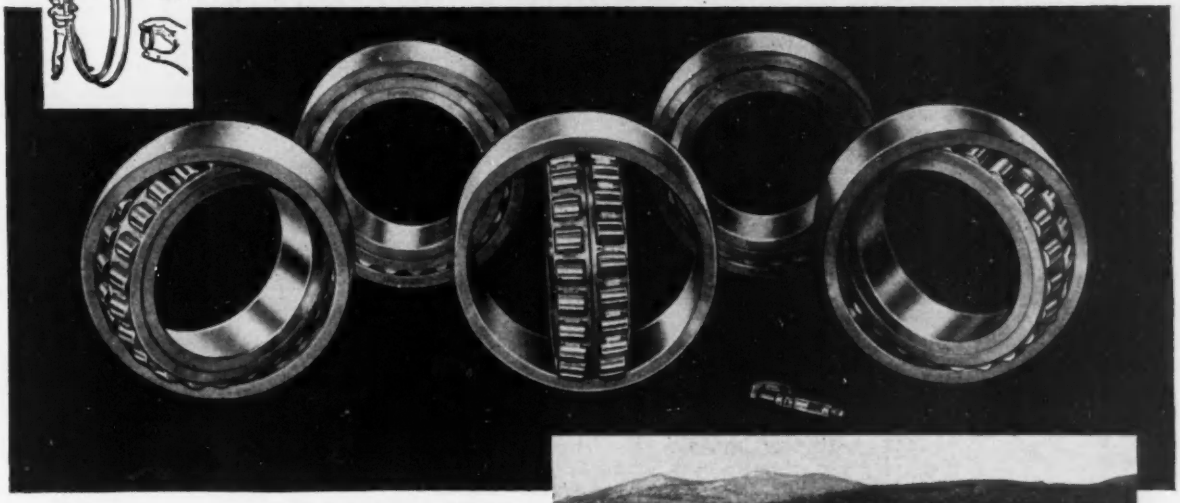
Name..... Title .....

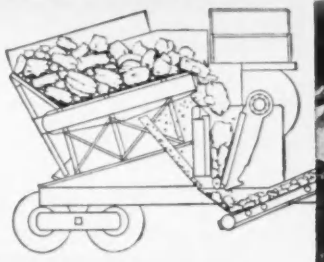
Company.....

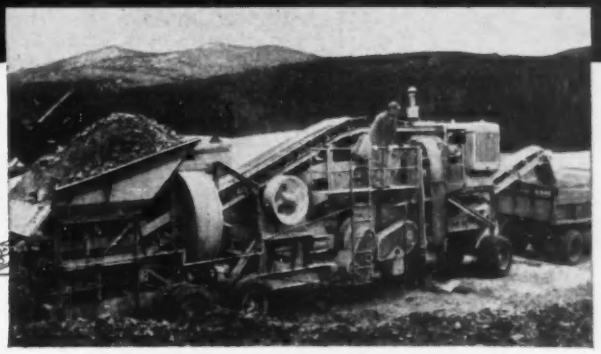
Address..... .2/53

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER







Spherical, self-aligning, anti-friction bearings, 8.6614" x 13.3858" x 3.5433", with one-piece bronze cage, as used in jaw crusher of this Cedarapids Junior Tandem Portable Crushing Plant, made by Iowa Mfg. Co., Cedar Rapids, Iowa. Other sizes of KAYDON Bearings, 12.5984" to 14.9606" Outside Diameter, are used on various models.

KAYDON-bearinged Cedarapids Jaw-Crushers are dependable!

ROCK crushing that used to be a slow, tedious, costly, "man-killing" job is made simple and profitable with famous Cedarapids portable crushing plants. Husky KAYDON precision bearings help the jaw crusher of this multi-ton machine operate smoothly and efficiently in crushing up to 75 to 135 tons of rock per hour into gravel sized 1-inch or less. • These rugged bearings help deliver maximum crushing power, assure smoother operation, reduce maintenance, and thus help improve production and profits.

On many types of heavy-duty industrial machinery and war equipment, big KAYDON bearings are making tough jobs easier, more profitable, with dependable, controlled precision. Machine designers welcome KAYDON bearing versatility. Frequently the adoption of these bearings leads to new horizons in bigger, better machinery for unusual quality-and-cost-control in modern production.

We'll be glad to work with you on difficult bearing problems.

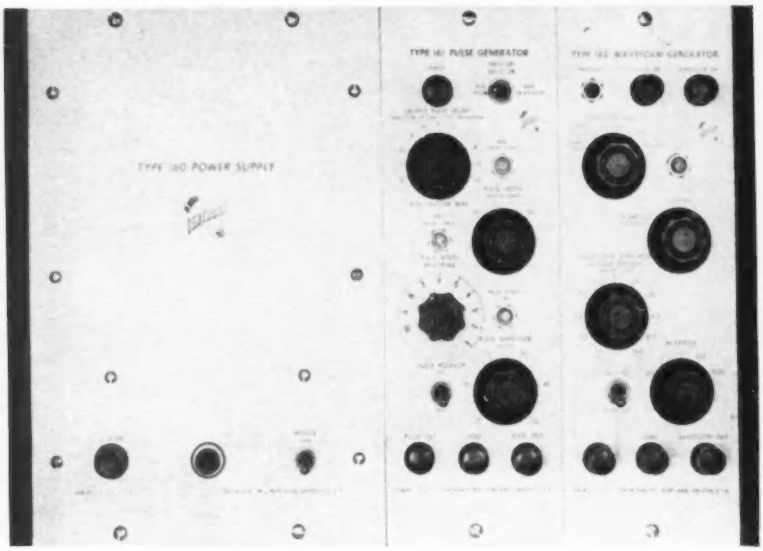
THE KAYDON ENGINEERING CORP.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

Special Waveform Generators



The instruments of this series, the type 160 Regulated Power Supply, type 161, Pulse Generator, and type 162 Waveform Generator, have been developed to give a source of controllable precision waveforms.

The type 160 regulated power supply will supply the necessary a-c and regulated d-c voltages to operate six of the other two units in any combination. It is regulated to compensate for line voltage fluctuations over the range of 105 to 125 v, and for changes in load.

The pulse generator is designed to supply calibrated rectangular output pulses of adjustable duration and amplitude, and of either polarity when the required trigger voltage is received from an external source. Two types of trigger waveforms can be used: a negative going sawtooth or a positive pulse. One output pulse is generated for each input pulse or each sawtooth cycle.

Positive Gate Characteristics: amplitude, 50 v positive from ground potential, not adjustable; duration, 10 microsec to 0.1 second.

Positive Pulse Characteristics: amplitude, 0 to 50 v, continuously variable; duration, 10 microsec to 0.1 sec continuously variable; risetime, 0.5 microsec; overshoot, less than 5 percent; delay, 0 to 100 percent of duration of input sawtooth.

Negative Pulse Characteristics: Identical with positive pulse, except polarity.

Output Impedance: Positive pulse, 1,800 ohms max; negative pulse, 5,000 ohms max; positive gate, 1,000 ohms maximum.

The waveform generator provides three types of waveforms of adjustable duration and repetition rate: pulse, gate and sawtooth. Generation of the waveforms can be initiated either by means of an externally derived electrical impulse, or by means of front-panel controls and switches. Pulse and gate waveforms have a minimum risetime of the order of one microsecond and an amplitude of 50 volts. The shortest pulse duration is of the order of 10 microseconds. The sawtooth waveform is a positive voltage decreasing uniformly from positive 150 v to positive 20 volts.

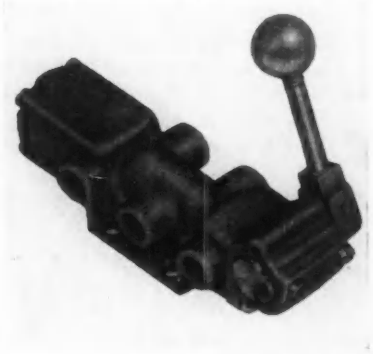
The device is useful for initiating chains of events electrically, and for controlling the duration of their occurrence and their repetition rate. When generating waveforms recurrently, the instrument provides a stable repetition rate.

Tektronix, Inc., Sunset Hwy. & Barnes Rd., Portland 7, Ore.

Wide Application of Two, Three, and Four-Way Valves

Modern design and versatility of applications are features of the new $\frac{1}{8}$ and $\frac{1}{4}$ NPT size line of pneumatic and hydraulic valves that include two-, three-, and four-way types with a choice of hand, foot, pilot, or cam actuating devices each with or without spring return. The same four actuating devices fit all three valve types in either size, and can be used either singly, or in any combination of two, to provide for any actuating requirement. In addition, all internal parts are interchangeable in the two-, three-, and four-way types. All valves can be completely serviced or disassembled with a screw driver without disturbing pipe connections—permitting rapid alteration, in the field.

Among the other features of the valve is the antiextrusion arrangement of all the kinetic O-ring seals in each valve type, which accounts for the airtightness. This feature makes it impossible to cut the seal rings in the normal operating pressure range of from 0 to 200 psig. These valves also have threaded exhaust ports. The transverse flow area in all types and sizes correspond to the pipe size of the valve. The small actuating force required is relatively unaffected by the line pressure since all types incorporate balanced pressure spool design.



Versa Products Co., Inc., 249 Scholes St., Brooklyn, N. Y.

CONTINUED ON PAGE 234

a proven steel

FOR GAS TURBINE STRUCTURES

N-A-X

AC9115 ALLOY STEEL

The production of gas turbines for jet aircraft engines and other uses is dependent upon metals which at both high and low temperatures have good strength, toughness, and stability before and after welding. N-A-X AC9115 ALLOY STEEL possesses these properties and is applicable to those parts where the operating temperatures range from −70° F. up to about +1000° F., and where suitable coatings are used for surface protection against normal and hot corrosion.

N-A-X AC9115 ALLOY STEEL has outstanding cold forming and welding characteristics and conserves critical alloys in its composition.

For more information about N-A-X AC9115 ALLOY STEEL, send for our new booklet.

A New Booklet For Design Engineers

Write for this 16-page booklet on N-A-X AC9115 ALLOY STEEL. It describes the properties and characteristics of this material and offers information on its fabricating and welding properties.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Makers of the famous **N-A-X**

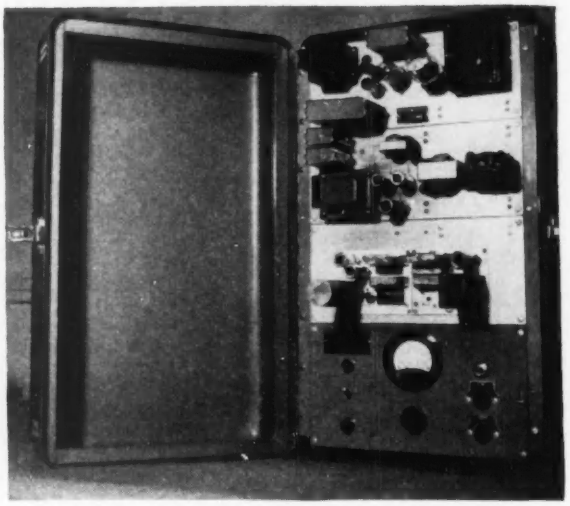
Alternator Constant Frequency Control

Designed to hold alternator frequency within 0.001 percent on motor-generator sets supplying up to 10 kw of power, a new constant-frequency control is used in industrial and laboratory applications where close frequency control is necessary. It is available in 50, 60, and 400 cycles per second standard in single or three phase. Non-standard frequencies are available.

Specific applications include the prevention of undesired hystersis and eddy currents effects in testing due to frequency variation; a standby source of emergency power for automatic and synchronous equipment; power supply for high frequency standard where one 60/400 cycle source supplies power to many parts of a plant and eliminated the need for a number of smaller sources. The control can also be adapted for use with a constant-speed mechanical drive.

The electronic control consists basically of a tuning fork and a phase comparator enclosed in a case approximately 6 x 24 x 36 inches. It operates on 115-volt, 50/60 cycle power, using about 150 watts. The motor-generator requires 115/230 volt d-c supply.

In operation, the output of the alternator of the motor-generator sets is held in synchronism with the tuning fork frequency standard by comparing the alternator phase with that of the tuning fork. As the alternator phase begins to lag, the current in the control winding on the main shunt field of the d-c motor is increased. The control field bucks the main field and increasing control field current tends to cause an increase in motor speed. Thus, the alternator is held in synchronism with the tuning fork



signal and does not gain or lose a cycle relative to standard.

Changes in load will cause the output to shift slightly in phase. But, the magnitude of this total shift is always less than plus-or-minus 90 deg from a set point. An anti-hunt circuit is used to improve stability.

General Electric Co., Schenectady 5, N. Y.

New Design of Speed Reduction Units

Called the Shaft-King, a new series of 20:1 ratio speed-reduction units features improvements in gears, bearings, housing, lubrication and oil sealing systems.

Gearing in the speed reducers consists of two trains of the single-helical type gears of flame-hardened alloy steel forgings.

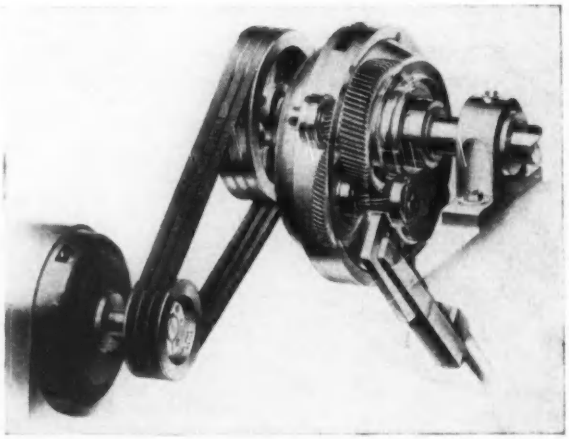
Another feature is the use of both ball bearings and tapered-roller bearings. Longer bearing and gear life is made possible by the three-wall housing.

Gearing and bearings are continuously splash-lubricated by the high-speed gear and the counter-shaft pinion which run in a large oil reservoir in the lower third of the housing.

The concentric shaft design places both input and output shaft above oil level, therefore bearing seals do not operate against a head of oil. An additional feature is a leak-proof, anti-friction oil-sealing system.

Interchangeable patented split tapered bushings with locking nuts eliminate fretting-corrosion and make the units adaptable to any shaft size up through 3-15/16 inches. The speed reducers can be mounted directly on the shaft of the driven machine and require only standard shaft lengths (twice the shaft diameter plus the clearance) for mounting.

As an additional protection against shock, jam or build-up loads, the speed reducers can be equipped with the



torque-arm overload release attachment which releases the unit upon excessive jamming or shock loads.

This mechanical overload is used on the reducer end of the torque arm, and is so constructed as to engage the housing stud of the unit.

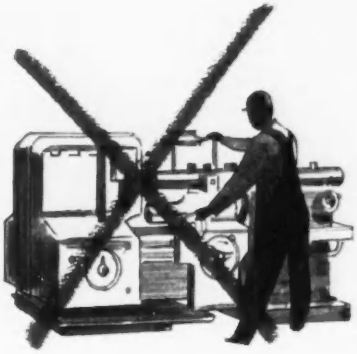
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.

CONTINUED ON PAGE 236

another case

where welded steel tubing does the job best...

From lengths of 2½" ELECTRUNITE Welded Steel Tubing to finished flash-hider being made for the Army Ordnance Corps by Will-o-Hill Industries, Willoughby, Ohio.



Cost Cut 92%!

Electrunite Welded Steel Tubing can run up interesting cost savings for you, too

● These flash-hiders for 20-mm. machine guns were formerly turned out of 3" solid bar stock. Cost was terrific, production rates were low, scrap generation was appalling. In other words, flash-hiders were really being made the hard way.

Using some top-flight native ingenuity, plus lengths of ELECTRUNITE Welded Steel Tubing, 2½" diameter, Will-o-Hill Industries, Inc., Willoughby, Ohio, now make flash-hiders for the Army at a breath-taking fraction of their former cost, and with *no scrap loss*. They are turned out faster, too, with less-skilled help, on low-hourly-cost punch presses, instead of on costly lathes.

ELECTRUNITE Welded Steel Tubing is successfully taking major deformation that even we never dreamed it would stand. What's more, Will-o-Hill report practically no spoiled or rejected pieces.

Does this give you ideas about using ELECTRUNITE Welded Steel Tubing in your products . . . to cut material and production costs, speed production, and produce better parts? We'd like to show you what's being done. And help you switch to ELECTRUNITE Welded Steel Tubing.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
224 EAST 131st STREET • CLEVELAND 8, OHIO

Republic REPUBLIC STEEL

ELECTRUNITE TUBING

Packaged Plug-In Circuits For All Uses

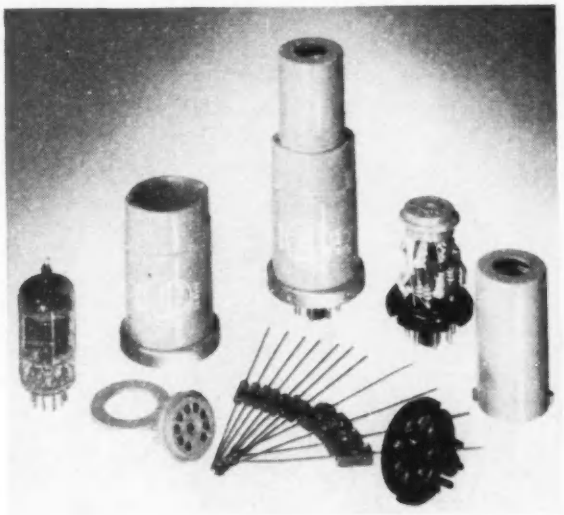
Used as building blocks, packaged plug-in circuits are being used in the design, development and production of electronic computing, high-speed counting, frequency and time measurement, and data transmission equipments.

Because most of the component parts are enclosed in the plug-in case, the backs of panels carry only the interconnection wiring between standard light-pin sockets. The plug-in components are contained in a die cast aluminum case about 4⅛ in. high by 1½ in. in diameter.

All the electrical parts of the plug-in, except the vacuum tube, are potted in a high-temperature potting compound, providing protection against humidity, corrosion, shock and vibration for operation at temperature from 0 to 80 C.

Each unit is designed to operate with other units of its class and type. Plug-ins can generally be integrated into existing equipment, because each unit has been designed to operate from both positive and negative supplies.

The line of plug-ins include: amplifiers; circuits; oscillators; gates; squaring circuits and R-C networks.



Electronic Engineering Co. of Calif., 180 S. Alvarado St., Los Angeles 4, Calif.

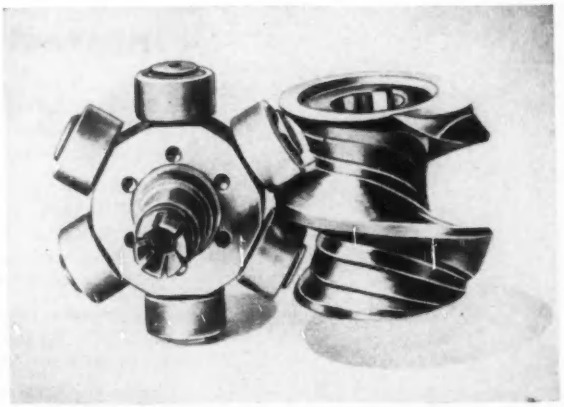
High Speed Roller Gear Drive

The roller gear drive, a new type of indexing or intermittent motion mechanism, permits high speed, precision, design versatility and low maintenance on any applications such as indexing dials, indexing carriers, indexing conveyors and indexing mechanisms. It has been used on dials and roll feeds, carrier chains and conveyors at speeds up to 800 pieces per minute to close tolerances and without auxiliary locating mechanisms.

Tests are said to have demonstrated that the roller gear drive will operate 8,000 hours (4 shift-years), when extreme precision is required, without maintenance. Where this extreme precision is not required, the drives operate up to 20,000 hours (10 shift-years) without maintenance.

The roller gear drive can be used for punch press dials with a precision of 0.001 for 12 in. dials. The drive has been applied to multi-color printing presses to feed paper webs intermittently at over 10,000 impressions per hour. Drives have also been designed for envelope folding machines and cap assembly machines, replacing geneva motions and other indexing mechanisms. Plant production rate is said to be increased by as much as 60 percent.

The roller gear drives are custom-designed with any number of stops from two to infinity. The indexing period, an entirely separate consideration, may vary from 25 to 100 percent of the total cycle time and either right or left hand rotation is obtainable.

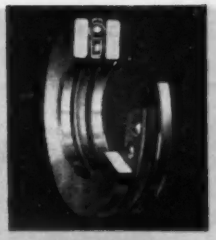


Ferguson Machine & Tool Co., Inc., 471 Paul Ave., Ferguson 21, Mo.

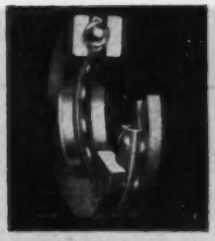
A NEW 1½ IN ILLUMINATED PANEL METER is available in model 150, round case, and model 153, square case, and has an external lamp housing. Illuminating miniature meters is accomplished with the use of a sealed peep window in the rear of the case. The small D'Arsonval type movement permits light admitted through the window to pass over the movement and be diffused through a translucent plastic scale. The source of illumination is a miniature aircraft lamp, mounted in a housing attached to the back of the instrument case, and supplied for 6, 14, and 28 volts. International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.

CONTINUED ON PAGE 238

B SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Bronze ball retainer . . . 38 sizes ½" to 3½" I.D.



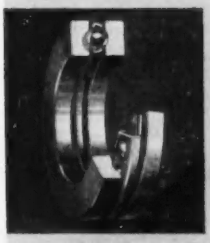
C SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Pressed steel retainer . . . 16 sizes ½" to 1¾6" I.D.



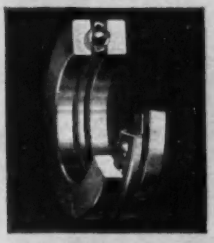
F SERIES • Light duty, one direction thrust bearing. Flat seat. Grooved races. Pressed steel retainer . . . 43 sizes ½" to 3½" I.D.

G SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 76 sizes ½" to 7¾" I.D.

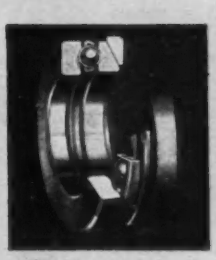
E SERIES • Medium duty ball thrust bearing. Banded. Flat seat. Grooved races. Full complement of balls . . . 40 sizes ½" to 3½" I.D.



1000 SERIES • Light duty ball thrust bearing. Flat seat. Grooved races. Pressed steel retainer. Metric standard . . . 26 sizes 10 to 125 mm. I.D.

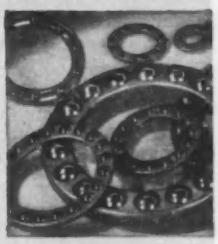


1100 SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.



1400 SERIES • Medium duty. Grooved races. Spherical seat. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.

W SERIES • Case hardened and ground flat washers for various Thrust and Spacer applications. Slip fit. 38 sizes ½" to 3½" I.D.



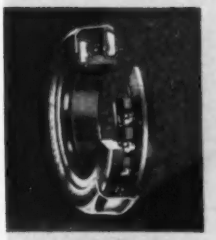
R SERIES • Ball thrust retainer. One piece, pressed steel, channel type cage . . . 79 inch sizes 0.266" to 4.232" I.D.

Just Name Your Need

Whatever mechanized equipment you make or use—whether it is large, small, rugged, fragile, heavy or light—whether it must operate at high speed, low speed, under water, in acid or under extreme temperature or dust conditions, it will do its job better, more efficiently and more economically if bearing equipped. If it is equipment that lends itself to bearing applications of the thrust type—Aetna has the answer or can come up with it pronto. 37 years of thrust bearing know-how assures this. Inquiries invited. No obligation. Aetna Ball and Roller Bearing Company, 4600 Schubert Ave., Chicago 39, Illinois.

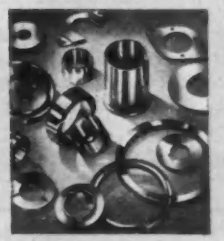
Aetna

Precision Bearings and Parts for Every Branch of Industry



CLUTCH BEARINGS • Ball thrust clutch release bearing. Banded. Pre-lubricated. T-type, oil impregnated bronze retainer assures concentricity and smooth, quiet, long-life performance.

SPECIAL BEARINGS • Facilities for sizes up to 38" O.D. Counsel that brings you the expert technical aid that has licked many of industry's toughest bearing application problems.

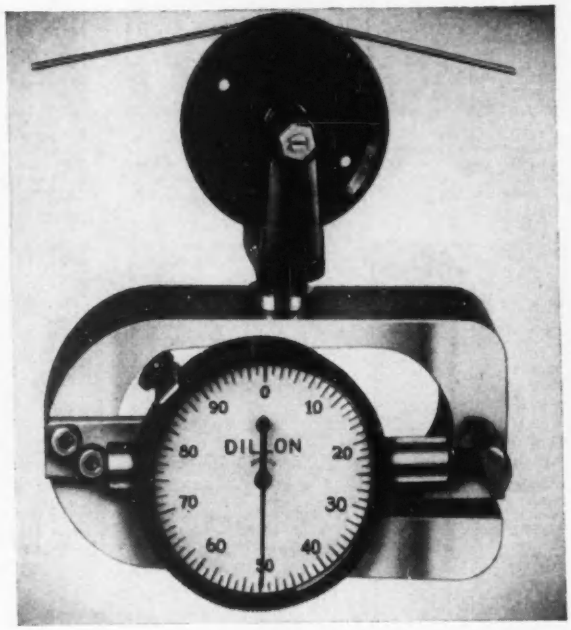


PRECISION PARTS • Aetna is versatile—can mass-produce vital parts in almost limitless sizes and shapes—to your most exacting metallurgical, tolerance and finish specifications.

Write **for latest catalog. Contains specifications on Aetna's complete line—vital technical reference data on bearing selection, load capacities, lubrication, care and maintenance.**

BRANCH OFFICES COAST-TO-COAST: • Albany • Atlanta • Auburn • Baltimore • Binghamton • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Denver • Detroit • Hartford • Houston • Jacksonville • Los Angeles • Newark • New York • Niagara Falls • Philadelphia • Pittsburgh • Providence • Richmond • Rochester • San Francisco • Seattle • Syracuse • Trenton • Utica • Waterbury • Worcester. See your classified 'phone directory for addresses.

Gage Measures Tension In Moving Cable



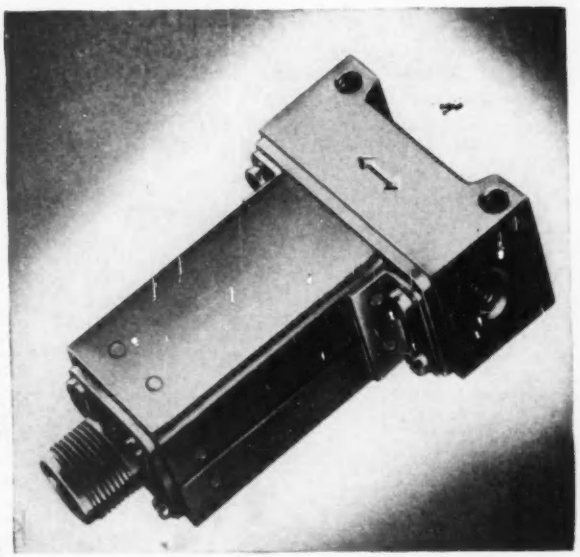
A new addition to a line of mechanical pressure gages is a model that is designed to measure the amount of tension in a moving or stationary cable, plastic filament, yarn, paper, or twine. Readings are taken directly in pounds by means of a dial indicator.

In operation the object to be measured passes over a ball-bearing sheave or roller. This sheave is mounted in a yoke which is screwed to the U-shaped pressure bar of the instrument. The bar itself is of heat treated alloy steel. Under downward pressure of the moving filament, it deflects only 0.039 in. for a full scale reading. Accuracy is guaranteed to within 1 percent of the indicated reading.

A threaded mounting hole is provided in the bottom half of the U-shaped pressure bar so that it can be mounted in special fixtures. Reasonable overloads do not harm calibration. This unit is provided in 10, 25, 50, 100, 250, 500, 1,000, 2,500, or 5,000 lb capacities. Shockless versions are also available. The largest model measures $4\frac{3}{4}$ x $2\frac{1}{8}$ x $3\frac{1}{8}$ inches.

W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Solenoid Valve With Low Pressure Drop



Having a low pressure drop, a floating shear seal, efficient operation, and good durability are the main features of a new solenoid valve having applications in the hydraulics field, air conditioning units, chemical plant processes, and other components in farm equipment.

The path of flow is directly in line with the tubing or connection to either side of the valve, reducing resistance.

The valve consists of three basic parts—the plunger, the disk, and the valve seats, which are held together in a housing. The valve is designed so that these parts are completely removable and easily replaced. The seats are loose inserts in the body, the plunger is a loose insert in the cylinder, and the seal disk is a loose insert in the plunger.

The plunger is flattened at the end, and has a hole in it which surrounds the carbon graphite disk. The disk is free floating. When it is in sealing position, the pressure of the fluid holds the disk against the seat.

Since only pressure causes the seal, the disk, which is actually floating, seals in either direction. Back pressure only causes the disk to move from one seat to another. As a result, the valve can be mounted in either direction.

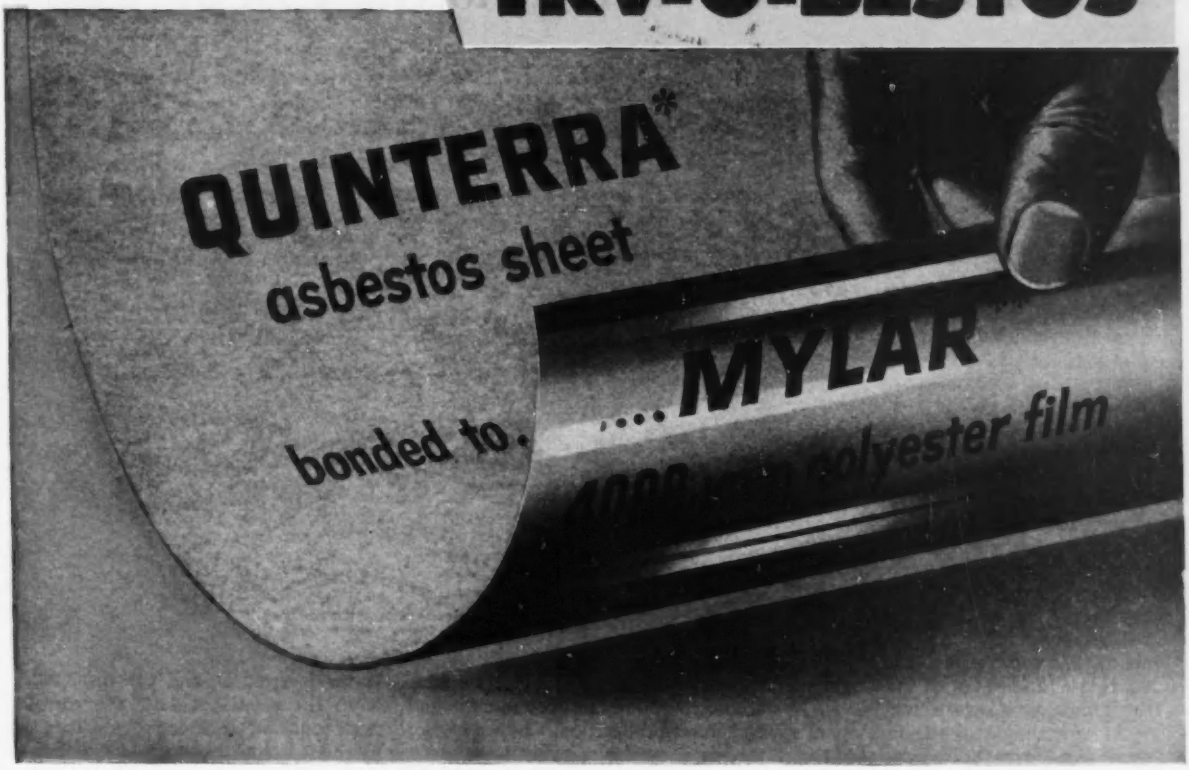
Valcor Engineering Corp., 314 Market St., Newark, N. J.

A NEW THERMOCOUPLE ASSEMBLY has been developed to detect temperatures in masses as small as plastic molds of two ounces. The unit consists of a $\frac{3}{16}$ in. O.D. stainless steel protecting tube, available in lengths of 3, 4, 5, 6, and 8 inches. The thermocouple is made of 20-gage Fiberglass insulated iron constantan. A flexible bronze armored tubing, in lengths of 4, 6 and 8 ft., is silver-soldered to the protecting tube. The leads may be made up in a condulet on a stationary part of the machine, leaving the thermocouple free to move with the mold during its cycle. Minneapolis-Honeywell Reg. Co., Wayne & Windrim Aves., Philadelphia 44, Pa.

CONTINUED ON PAGE 240

A NEW IRVINGTON CLASS "B" INSULATION...

IRV-O-BESTOS®



By bonding a range of thicknesses of Quinterra asbestos to various thicknesses of Mylar—a tough, strong polyester film with the highest dielectric strength known—Irvington now brings you a line of Class "B" insulation that balances cost and properties to meet your needs. The Mylar gives IRV-O-BESTOS its high tensile, tear and dielectric strength. The Quinterra makes for ease of gripping—gives added heat stability and added thickness at moderate cost.

Since Quinterra is available in thicknesses from .003" to .015", and Mylar from .0005" to .007", a very large number of combinations are available—in duplex constructions or in triplex, with either the Quinterra or the Mylar on the outside. Whether your requirements are for high dielectric strength, or for added thickness at low cost, IRV-O-BESTOS will fill your needs.

Look to
IRVINGTON
for Insulation Leadership

INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
CLASS "H" INSULATION

Mail the coupon for technical data and samples of this outstanding new Class "B" insulation.

*Johns-Manville Corp. trademark **du Pont trademark

Send this convenient coupon now

Irvington

VARNISH & INSULATOR COMPANY

10 Argyle Terrace, Irvington 11, New Jersey

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

PE-2-53

Irvington Varnish & Insulator Company
10 Argyle Terrace, Irvington 11, N. J.

Gentlemen:
Please send me technical data sheet and samples of your new IRV-O-BESTOS Class "B" insulation.

Name.....Title.....
Company.....
Street.....
City.....Zone.....State.....

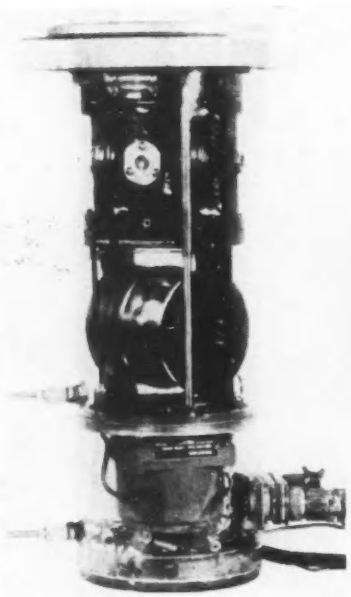
Pressure Meter Accurate to One Part in 5,000

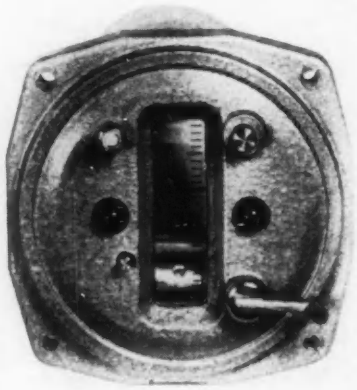
Said to be as accurate as the most sensitive mercury manometer, a new pressure-measuring instrument called the Press-I-Cell can measure with an accuracy of one part in 5,000. Measuring 5 in. in dia, and 14 in. in length, the instrument is portable, temperature-stable, and unaffected by vibration or mounting position. Typical applications are: a master laboratory instrument for calibrating other pressure-sensing instruments; precision measurement of altitude or barometric pressure; a liquid level gage for large storage tanks; field tests requiring high precisions or sensitivity with a compact test gage.

The scale is 600 in. in length with an interval of $\frac{1}{16}$ in. on the scale representing 1/10,000 of the full pressure range. The scale printed on a 35 mm film strip, is almost unaffected by temperature or humidity changes, since the reading portion of the scale is held to constant length by means of a pair of winding sprockets spaced two inches apart. The movement of those sprockets is synchronized with the action of the pressure follow-up system.

As an example of the instrument's sensitivity the manufacturer claims that the instrument will measure the drop in atmospheric pressure when it is raised about 6 in. above the table on which it rests.

The instrument can be equipped to operate over a wide range of absolute or gage pressures or differentials. Typical pressure ranges are 1 atmosphere absolute, 400 in. water column, and 150 in. Hg differential. Either of two models is available: manual, in which the proper scale position is found by manual setting; and automatic, in which the scale is correctly positioned by a servomotor. In the automatic instrument, the correct reading is obtained with no hunting or oscillation of the scale. Repeatability of the meter is rated at one part in 7,000.





In the model at left, the correct scale position is found automatically by the servomotor at the bottom of the case, and the amplifier (not shown). The top of the instrument, where film scale is read, the only part showing when mounted, is shown by the manually-operated model at right.

Fischer & Porter Co., Hatboro, Pa.

Piston Type, Multi-Range Pressure Switch

Available in 8 different ranges varying from 125 to 7500 psi, a new piston type multi-range pressure switch will operate between —65 F and 250 F. Known as the 600 series, its calibrations are not affected by acceleration, shock, vibration, or excessive pressure surges. The switch is adjustable within any single range, and has a low "on—off" differential pressure at all times, high sensitivity, and low temperature reliability.

The switch is constructed of aluminum die casting and stainless steel. Weight is from 14 to 16 oz., depending on pressure range and electrical connections. The envelope of the switch is the same for all ranges in the series, and parts of all models except the main spring are identical.

The manufacturer claims the switch may be used in warning signals, in sequencing circuits, in interlocking controls, and in other similar applications. The new switch is also suitable for control in medium and high pressure systems using either hydraulic fluids, water, air or gas and corrosive liquids or gases.

The pressure switch can be mounted in any position including irregular surfaces, has an acceleration factor of 40 g's, and a proof pressure to double maximum operating pressure.

Bobrick Mfg., Corp., 1839 Blake Avenue, Los Angeles 39, Calif.

CONTINUED ON PAGE 242

For any shaft that turns . . . welded tubular design gives the most strength at the least weight!

• Pound for pound, a tubular section will carry more torsional load than any other shape. This, plus ease of fabrication, accounts for the universal use of electric-welded steel tubing for automotive drive shafts, torque tubes, etc.

Investigate the economy and physical advantages of Brainard welded steel tubing for *your* products. Write Brainard Steel Division, Dept. GG-2, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

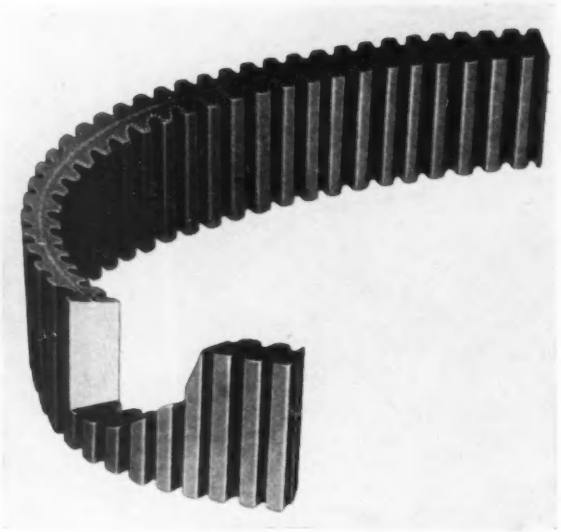
WELDED STEEL TUBING

New V-Belt For Variable Speed Motors

With its original design limited to about 5 hp, a v-belt, variable speed drive unit called the Varidrive now uses a double corrugated belt which reduces internal friction and permits greater flexibility of the belt. Synthetic fibres are used in the rubber belts, permitting greater loads and speeds, smaller diameters, and smaller cables in the neutral axis.

While belts can be made somewhat elastic to help maintain proper tension, the correct tension is maintained automatically in this variable speed unit by a calibrated spring opposing the normal separating effect of the belt within the disks. Called the Autotaut, it maintains the pressure between the two halves of the driven disks and the sides of the belt. This pressure is balanced by the wedging action of the belt tension regardless of the wear of the belt.

U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.



Low Distortion Battery Operated Oscillator

Designed as a source of signal power for field use, the new model MB-1 portable oscillator gets its operating power entirely from self-contained batteries and covers a frequency range in four decade ranges of: 2 to 20 cps; 20 to 200 cps; 200 to 2,000 cps; and 2,000 to 20,000 cps.

The power switch has two power output positions, high and low, so that in applications where maximum signal amplitude is not necessary, battery life may be extended by leaving the switch in low position. The ouput is 2.5 v into a 2,000 ohm load in low battery position, and 5.5 v into a 2,000 ohm load in high battery position. The instrument has an internal impedance of approximately 400 ohms.

Distortion is less than one percent in the audio spectrum, and the dial is accurate to within 2 percent of its indication. Frequency stability is ± one percent on all ranges; amplitude stability is ±5 percent.

The batteries are housed in a separate compartment so that they may be replaced in the field without exposing the circuit to dust and weather. Poor operation as a result of moisture condensates has been minimized by circuit design and by the use of a special range selector switch.

Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston, Tex.

A MOLDED PAPER CAPACITOR, for continuous operation at temperatures up to 125C is impregnated with Prokar, a high temperature organic material which is polymerized to a solid resin. The impregnated sections are molded in high temperature plastic. Designed model 85 P, the unit is available in 2 mold sizes: 0.175 in. dia by $\frac{5}{8}$ in. long; and 0.200 in. dia by $\frac{5}{8}$ in. long. Sprague Electric Co., 195 Marshall St., North Adams, Mass.

DESIGNED FOR USE IN TV SETS and small radios, a new $\frac{3}{4}$ in. dia miniaturized variable composition resistor, type 70 has a wattage rating of 0.3 watt for resistances through 10,000 ohms, and 0.2 watt with 350 v max across the end terminals for resistances over 10,000 ohms. Angle of rotation is 300 deg ±5 degrees. A variety of resistance tapers are available. Type 70 is arranged for mounting with $\frac{1}{4}$ in. dia 32 pitch threaded bushing, and has a $\frac{1}{8}$ in. dia shaft. Chicago Telephone Supply Corp., Elkhart, Indiana.

CONTINUED ON PAGE 244

Easy on ..to Stay on.. yet easy Off..

Republic Upson "Nylok*" Nuts

It's easy to start a Republic Upson "Nylok*" Nut . . . either end is "up". . . no special tools . . . no special techniques.

Wherever you stop wrenching, that's where the nut *stays* . . . even under severe vibration. The nylon plug in the side makes the nut hold tight.

And when it's time to remove a Republic Upson "Nylok*" Nut, just back it off. The nylon plug can't gall, can't rust. Best of all, the nut is ready to *re*-use . . .

SIZES

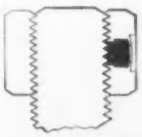
Light series tapped ¼" thru ⅝"
Light thick series tapped ¼" thru ½"
Regular sizes tapped ¼" thru ½"
Heavy series tapped ¼" thru ½"

12 WAYS BETTER

Assemble from either end	No special tools
Can be re-used	One piece
Non-galling	Ideal for mechanical feeding
Best wrenching characteristics	No lubricant needed
Won't damage threads	Cold-forged
No special know-how	Lock in any position

Write for samples . . . tell us sizes you use.

REPUBLIC STEEL CORPORATION
Bolt and Nut Division • CLEVELAND 13, OHIO
Expert Department: Chrysler Building, New York 17, N.Y.



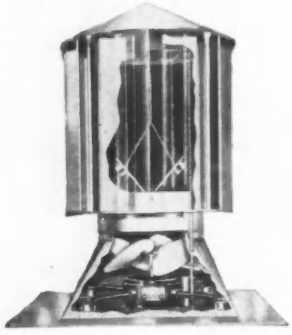
Here's how the "Nylok" principle works
A nylon plug inserted in one of the sides of the cold-forged nut forces the nut tight against the opposite threads as the nut is turned on.

*U. S. Pat. No. 2,462,603 and pending applications

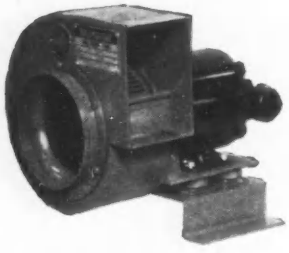
Republic
REPUBLIC STEEL
UPSON QUALITY BOLTS AND NUTS

SHOCK AND VIBRATION NEWS

Exhaust Fans Quieted by Vibration Isolators



The problem of motor and fan noise is successfully overcome in the Breidert Air-X-Hauster by use of four air-damped Barrymounts that support the low-speed motor and fan assembly. These isolators absorb the motor and fan vibration, keeping it from reaching building members or metal ducts along which it would otherwise be carried or amplified. To assure adequate isolation, the mountings used were type 990 Barrymounts having a natural frequency of only 8 cps.



Another example of use for Barrymounts in ventilating systems is with the high-speed Westinghouse-Sturtevant multi-vane, railway car fan. Here they isolate fan vibration for quieter operation and protect the assembly from the shocks incidental to mobile service. In this application, type C-2000 Barrymounts were used to provide protection against forces applied laterally as well as vertically.

Your vibration or noise problem may be solved by a simple application of Barrymounts. Ask our Field Engineering Department; they'll gladly help you. Or write for Catalog 504-B, describing Barrymounts for a wide variety of uses.

Miniaturized Vibration Isolators Help Cut Space and Weight in Fuel-Gauge Power Unit

70% size reduction and 50% weight reduction — with no loss of performance — is the effective miniaturization obtained in the new Minneapolis-Honeywell aircraft-fuel-gauge power unit. Miniature, air-damped Barrymounts, Type 6465, helped M-H engineers in this achievement.

These vibration isolators, in which size and weight have been cut while operating characteristics have been maintained, will help you redesign for miniaturization.

Check these useful features of miniaturized Barrymounts.

Light weight — only 5/16 ounce each.

Small size — 1" diameter 11/32" loaded height.

Resonant frequency — 9 cps

Transmissibility at resonance — 3

Wide load range — 0.1-3 pounds

4 different styles available — for plate or stand-off mounting.

Write for data sheets 605 and 606 giving details of dimensions and load ratings.

FREE CATALOGS

- 523-A — Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509-A — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504-B — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.

THE **BARRY** CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

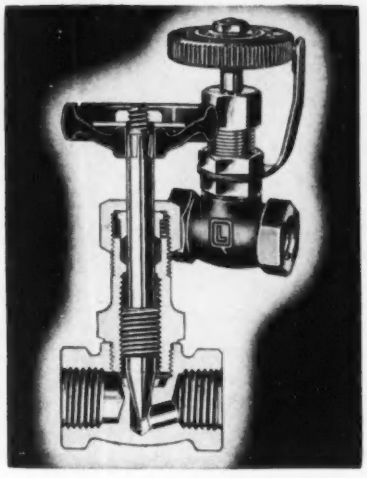
SALES REPRESENTATIVES IN

Atlanta Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

Gland Type Bronze Needle Valve

A new gland-type bronze needle is small, compact, and made in a full range of sizes from $\frac{1}{8}$ in. to 1 in. in both globe and angle patterns, making it applicable for use in pin-point control on small lines where fine regulation of flow is essential.

This new control valve is also being produced in an indicator model. The indicator needle globe valve is available in $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{1}{2}$ in. sizes; and in the angle type valve it is available in $\frac{1}{4}$



in., and $\frac{3}{8}$ in. sizes. The handwheel on the indicator needle valve is of cast bronze and has numbered graduations indicated on its face. A spring clip engaging serrations on the outside of the wheel, holds the valve at the correct setting.

Both regular and indicator patterns are made with deep, well-packed stuffing boxes and use hexagon gland followers.

Lunkenheimer Co., Cincinnati 14, Ohio

ID-OD Piston Gage

Two operators of a fast, positive-operating multi-dimension gage measures all the critical diameters of automotive and aircraft pistons.

With the dual-measuring air plug in a vertical position, the operator loads the piston and checks both ends of the wrist pin holes for I. D., taper and bellmouth. The air plug is then rotated 180 deg to explore for out-of-round and other hole conditions. Any variation from a master setting is noted by the Dual Dimensionair, (right, foreground in the illustration).

As the gage handle is pushed for-

BROOKLYN was "unprintable"

Recently, The Consolidated Edison Company (in New York City) faced this problem: It had to produce a direct-process print from each one of more than ten thousand Brooklyn Underground Record Maps, showing the distribution system of electric service.

But satisfactory prints could not be produced directly from these maps. They were up to 30 years old . . . had been referred to constantly . . . and as a result were soiled, stained, creased, and "dog-eared."

What to do? Retracing was out of the question, since it would take a draftsman from two to three days to trace and check just one of these 17″ x 25″ drawings.

Kodagraph Autopositive Paper was the speedy, economical solution

With this revolutionary photographic intermediate paper, approximately 40 sharp and clean "duplicate originals" could be turned out in an hour. *Yes, 40 in an hour* because Kodagraph Autopositive Paper produces positive copies directly—without a negative step, without darkroom handling. At the same time, it drops out stains, creases . . . cleans up backgrounds . . . transforms weak detail into dense photographic black lines. Furthermore, Autopositive Paper can be exposed in standard print-making equipment . . . and processed in standard photographic solutions.

Thus, Consolidated Edison obtained—*in record time and at minimum cost*—a complete set of duplicate originals which were used to produce the required direct-process prints . . . and were then filed away for future reference work and print-making needs.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

Learn in detail all the ways you can save with Kodagraph Autopositive Paper—the revolutionary photographic intermediate material which you, or your local blueprinter, can process *quickly . . . economically . . . at low cost.* Mail coupon today for free booklet!

15

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of "New Short Cuts and Savings"... describing the many savings Kodagraph Autopositive Paper is bringing to industry.

Name _____ (please print) _____ Position _____

Company _____

Street _____

City _____ Zone _____ State _____

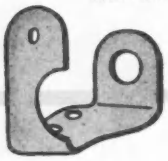
Kodak
TRADE-MARK

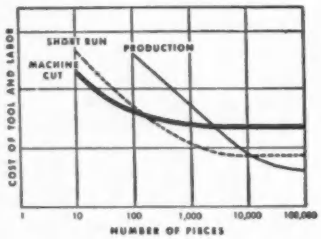
STAMPINGS

Our impartial use of three basic methods gives you economy regardless of length of run.

Most parts can be made by all three methods. But only **one** is **most** economical. The right decision is a technical one, based on **over-all** quantity, contour dimensions, tolerances and materials.

YOUR SUPPLIER SHOULD KNOW ALL THREE METHODS





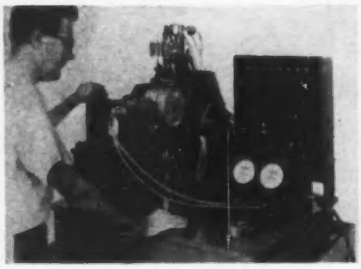
This logarithmic chart shows the effect of these factors on the specific part illustrated. From 1 to 150 parts, our own **Machine-Cut Method** with no die cost whatsoever is most economical. At 150 parts, the **Short-Run Method** using economical blanking dies and stock punches is best. At 10,000 units, the standard **Production Method** with standard dies is most satisfactory.

For more information, use coupon on opposite page

STAMPINGS DIVISION

LAMINATED SHIM COMPANY, INC.

1402 Union Street, Glenbrook, Conn.

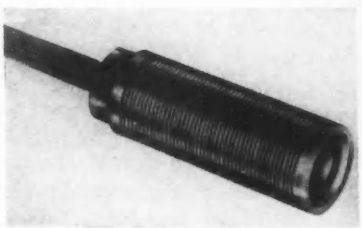


ward, the piston takes a horizontal position between the contacts. Here all O. D.'s are simultaneously inspected for out-of-tolerance by eight floating gage units and off dimensions are shown on the while on black "picture panel." Red lights show oversize; amber, undersize. These floating units are sensitive to small O. D. variations. They are small and compact, enabling multiple gaging at close quarters.

Federal Products Corp., 1144 Eddy St., Providence 1, R. I.

Short Slip Ring Assembly

Designed for use in miniaturized light weight test units, a new, short slip ring assembly with 46 independent circuits measures only 1.935 inches. Individual rings are 0.023 in. wide,



and barriers between rings are 0.020 in. in width. Each ring is located within 0.002 in. of its nominal dimension over the 1.935 in. of active length. Gold finish is used to maintain a constant low voltage drop between the wire brushes and the rings.

Electro Tec Corp., So. Hackensack, N. J.

Frictionless Precision Torque Balances

Particularly suitable for use in the metalworking field, a new line of precision torque balances feature a torsion system that eliminates mechanical axle friction. In drawing and finishing of Tungsten wire or similar materials, it is impractical to measure in any other manner than the weight per unit length. Large numbers of weighings can be made in a short

Books Serve as Tools in Defense Production

Defense production needs have put the spotlight on today's rapid technical developments—in machines, materials, processes, and management. New demands for know-how and skill face your personnel, from top engineering design down through the many levels of supervisory and mechanical shop work. Make sure you get the maximum efficiency and production from your whole staff—give them the advantages of the technical training and upgrading afforded by McGraw-Hill books.

Mechanical Engineers' Handbook

Provides practical data on every branch of mechanical engineering—from aeronautics to mechanical refrigeration, from power generation to welding, from metal-cutting to hoisting and conveying. New materials in the 5th edition include fluid mechanics, aircraft jet propulsion, plastics, industrial supersonics, rocket fuels, and many more. **Edited by Lionel S. Marks, Gordon McKay, Prof. of Mech. Eng., Emeritus, Harvard Univ. 5th Edition, over 2200 pages, 1500 illus., $15.00**

Tool Engineers Handbook

An outstanding reference bringing you authoritative data on the design, fabrication, maintenance, and economical use of industrial tools and machinery. It covers everything from product design and cost estimating . . . through the economical selection of machines, processes and tools . . . to the analysis and improvement of setups and operations. **By American Society of Tool Engineers, F. W. Wilson, Editor-in-Chief. 2150 pages, over 2000 charts, table and diagrams. $15.00**

Handbook on Designing for Quantity Production

Provides the tested rules to enable you to design more economical product parts for mass production quicker. Gives you hundreds of design pointers to follow in designing basic parts for quantity production by stamping, sand casting, die casting, screw machine, die forging, etc., and new material on wire forms, permanent mold castings, impact extrusions. **By Herbert Chase. 2nd Edition, 561 pages, 417 illustrations, tables and charts, $7.50**

Quality-Control Handbook

An outstanding reference bringing you authoritative data on the design, fabrication, product quality at lower cost. Use it for basic or advanced review of all phases, not only the statistical, of the quality-control function—for quick reference to many formulas, data, record forms, and other practical information. Covers economics of quality control; organization for quality; acceptance, control, and assurance of quality; application to specific processes and products. **Edited by J. M. Juran, Consulting Management Engineer. 768 pp., 6 x 9, 176 illus., $10.00**

Materials Handbook

Presents the most pertinent and important facts relating to more than 8300 materials to enable executives purchasing agents, and engineers to make comparison, avoid checking many sources, and quickly get a working knowledge of the materials best suited for a particular purpose. Gives detailed information on chief characteristics, comparative data, sources, substitutes, adulterants, and uses for each material. Includes a section on economic geography of materials. **By George S. Brady. 7th Edition, 879 pages, $8.50**

SEE THESE BOOKS 10 DAYS FREE

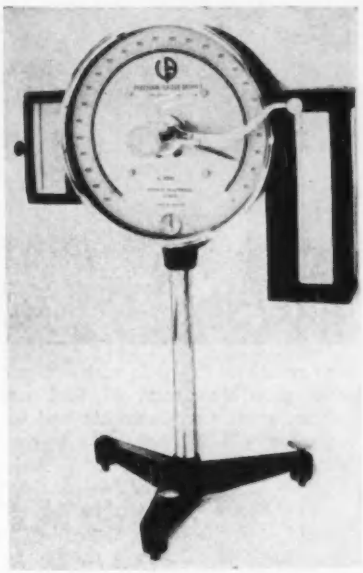
McGRAW-HILL BOOK COMPANY, INC.
330 W. 42nd Street, NYC (36)
Send me book(s) checked below for 10 days' free examination on approval. In 10 days I will remit for book(s) I keep plus a few cents for delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon—same return privilege.)

- ☐ Marks—**MECHANICAL ENGRS. HDBK.—$15.00**
- ☐ ASTE—**TOOL ENGINEERS HDBK.—$15.00**
- ☐ Chase—**HDBK. ON DESIGNING—$7.50**
- ☐ Juran—**QUALITY-CONTROL HDBK.—$10.00**
- ☐ Brady—**MATERIALS HDBK.—$8.50**

(Print)

Name .....
Address .....
City ..... Zone..... State.....
Company .....
Position PPE-2-53

This offer applies to U. S. only.



time. The sampling device is constructed to insure uniform lengths of wire regardless of individual operator differences. A special wire cutting accessory for tungsten is also available.

The balances are also equipped with a special damping device which speeds weighing, but does not affect the sensitivity. Other features include eye level reading, resistance to shock; and reading device which eliminates parallax and does not have a vernier.

The instruments are available in models with capacities from 1 milligram to 20 grams, and with sensitivities from 0.002 milligram to 0.02 milligram.

Ohaus Scale Corp.,
1050 *Commerce Ave., Union, N. J.*

Small, 10 Amp. Hermetically Sealed Relay

Claimed to be one of the smallest and lightest relays for its rating, a hermetically-sealed aircraft relay, A52-111 is rated at 10 amp, DPDT, 28v, or 115v 400 cycles a-c. The unit weighs 4.8 oz., enclosure measures $2\frac{7}{16}$ in. x $1\frac{3}{16}$ in. x $1\frac{9}{16}$ in., and has individual terminal lugs.

The new relay has the identical rotary armature structure, with balanced design and contact linkage which has been AN approved in larger enclosures, and is designed to satisfy the requirements of Specification MIL-R-6106. According to the manufacturers, the relay has been vibration tested for 1,000,000 cycles of operation, and has been found free of resonance over frequencies between 5 and 200 cps, with amplitudes varied to hold 5 G's. The relay is said to have

SHIMS

BRING YOUR SHIM PROBLEMS TO "SHIM HEADQUARTERS"

ONLY LAMINATED SHIM COMPANY OFFERS YOU ALL FIVE SOLUTIONS:

THE LAMINUM* SHIM — "looks like solid metal!"
SIMPLY PEELS FOR ADJUSTMENT
Made up of from 3 to 63 layers of .002 or .003 inch brass or steel, metallically bonded together over their entire surfaces. No dirt between layers. Peels with penknife.

THE LAMISOL* SHIM — "just spot-soldered on the edges"
FOR QUICK, ASSEMBLY LINE USE
The laminations of the LAMISOL Shim (in brass only) are temporarily joined by spot-soldering on the edges. Gauges and number of laminations within one shim are unlimited.

THE LAMITAB* SHIM — "the little tab holds 'em together"
FOR SUPER SPEED, THIN GAUGE SITUATIONS
The little tab holds shim laminations together firmly, yet is easily removed. Different metals can be used in the same shim.

THE LOOSE LEAF SHIM — "all separate, any gauges you want"
FOR UNLIMITED FLEXIBILITY
This is the simplest of all custom-stamped shims. It is completely flexible. Usually sets including several different gauges are made up.

PACKAGED SHIM STOCK — "swell for hand cutting simple shims"
READY FOR EASY USE, WITHOUT WASTE
Thin gauge 6" x 100" rolls feed through package slots. Heavier gauges in flat envelopes. Available from your Industrial Distributor.

*T.M. Applied for

LAMINATED SHIM COMPANY, INC.

SHIM HEADQUARTERS SINCE 1913
Check Our Stampings Division For Your Stamped Parts Requirements

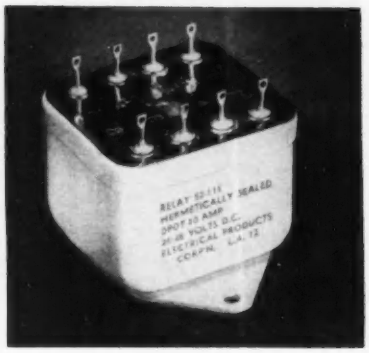
USE COUPON for more information

MAIL TODAY!
LAMINATED SHIM COMPANY, INC.
1402 UNION STREET, GLENBROOK, CONN.
Please send me more information on:
☐ SHIMS ☐ STAMPINGS ☐ BOTH
☐ *We'd like to discuss our problem with one of your Sales Engineers.*
NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE _____ STATE _____

● Special fasteners are our specialty. Use our experience to solve your problems with Circle B bolts designed and made to your particular requirements. You can improve your product design and performance . . . while cutting assembly time and costs.

● Look to Buffalo Bolt for the direct answer to your fastener problems. Start right by writing for details today. Your inquiry will receive special attention, too. Ask for standard fastener Catalog No. 51 when you write.

BUFFALO
BOLT COMPANY
Division of Buffalo-Eclipse Corporation
North Tonawanda, N. Y.
Sales Offices in Principal Cities
PRODUCERS OF CIRCLE B PRODUCTS — BOLTS • NUTS • RIVETS AND SPECIAL FASTENERS

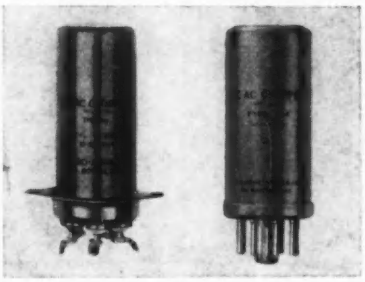


high resistance to shock, vibration and acceleration, in excess of civil and military aircraft requirements, and has withstood 125 G's of shock without damage.

Electrical Products Corp.,
1100 N. Main St., Los Angeles, Calif.

Non-Plug-In Model Chopper

Designed with emphasis on long life and low noise level, these electro-mechanical precision vibrators are used as modulators or demodulators. As modulators, these choppers convert pure d-c into pulsating d-c or a-c, and as demodulators they reconvert to d-c.



In this way, the output of thermocouples, strain gages, and other low level d-c equipment may be amplified by means of an a-c rather than a d-c amplifier. In servomechanism applications, the chopper is used as a means of converting error voltages for a-c amplification. Range is 10-500 cps.

The type 364 is plug-in, and the type 365 a non-plug-in.

Stevens-Arnold, Inc.,
22 Elkins St., Boston 27, Mass.

Multi-Purpose Solenoid Pilot Valve

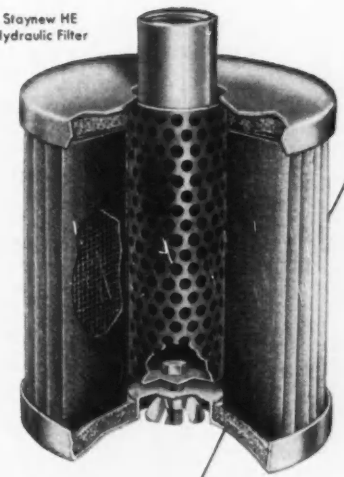
Air, vacuum, oil, water, and inert gases are handled by a new solenoid pilot valve which measures 3 in. in height. The body and cover are of high tensile zinc base alloy. The standard coil is adaptable to either continu-

INSTALL STAYNEW HYDRAULIC AND BREATHER FILTERS

As Original Equipment on Your Hydraulic Machinery

Fit the filtering requirements of your hydraulic machinery to your specific needs by installing Staynew Hydraulic and Breather Filters.

Staynew HE Hydraulic Filter



Staynew BR Breather Filter

DOLLINGER PROTECTO-MOTOR STAYNEW FILTERS

HYDRAULIC FILTERS

Compact, simplified filters for use wherever dirty liquids are collected, filtered or recirculated. Wide range of metallic mesh and fabric media are available. Long operation assured without cleaning or replacement.

BREATHER FILTERS

Permit practically constant interior pressure by allowing atmospheric air to be drawn in or exhausted as required—while preventing entrance of impurities and escape of liquid mist or fog.

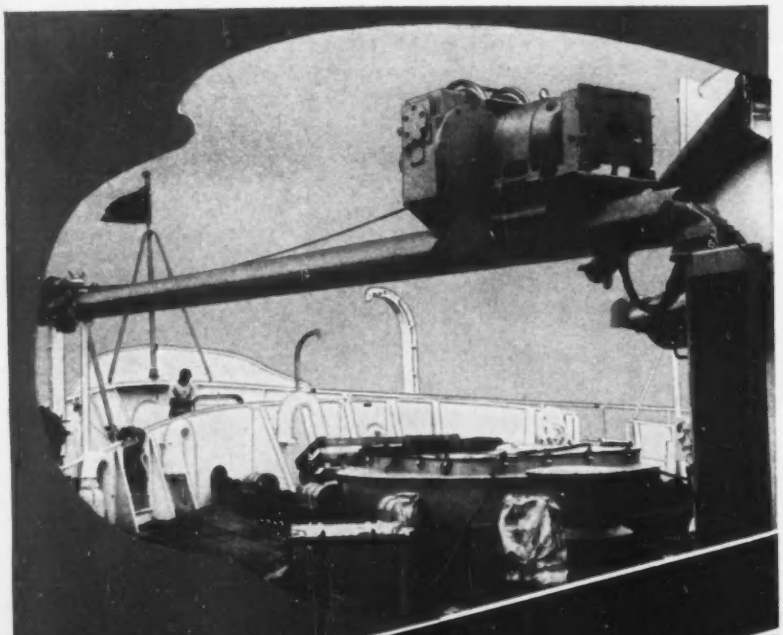
When you build this perfect combination into your hydraulic machinery, you'll save costly equipment wear, spoilage, and maintenance time.

Let our Engineering Department solve your hydraulic filtration problems. Write today for Bulletin HF-2.

Representatives in Principal Cities

DOLLINGER CORPORATION, 80 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



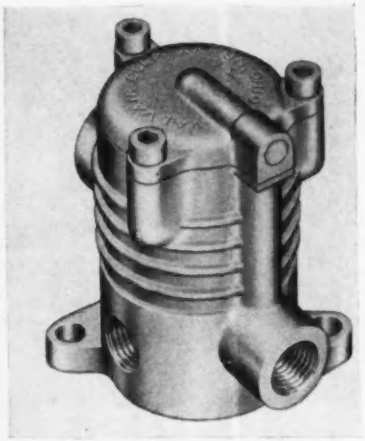
Compact power for winches & hoists ... with Cone-Drive Gears

Designed and built by Lake Shore Engineering Company of Iron Mountain, Michigan, this boom-mounted cargo winch is operated by Cone-Drive gears. Advantages include: ability to take shock loads, long-life, dependability, and unusual compactness.

Although a 20:1 ratio Cone-Drive gearset of only 7-inch center distance is used, this compact gearing provides a 27.7 mechanical horsepower rating at 1150 worm r.p.m.

No wonder leading producers of hoists and winches are turning more and more to standard Cone-Drive double-enveloping gears.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan



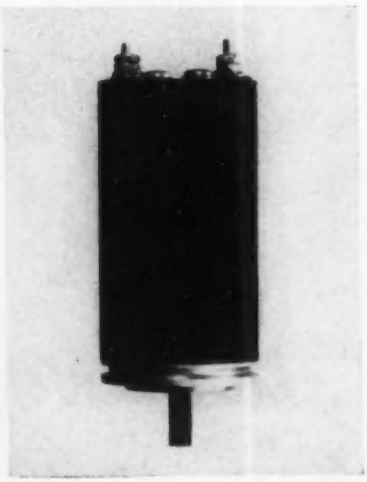
ous or intermittent service, and is completely sealed from but is cooled by the fluid or air passing through the valve. There are two moving parts: plunger and stem. The stem is one-piece and unbreakable. Sealing is by Hycar O-rings.

The valve can be drilled through the bottom for manifold mounting. Models include 2-way and 3-way either normally open or normally closed. The following orifice sizes are available: $\frac{1}{16}$ in., $\frac{3}{32}$ and $\frac{1}{8}$ in. with $\frac{1}{4}$ in. pipe tap.

Valvair Corp., Beardsley Ave., Akron 11, *Ohio*

Miniature D-C Generator For Servo Systems

Similar to the Moto-Mite, a permanent magnet motor made by his company, the d-c generator shown below has been designed specifically for generator applications to provide units of high voltage output per unit of speed. The "slot-lock" effect and the inherent friction have been re-



duced. These features are said to make the generator useful as a rate device in servo systems, as it is a small, lightweight package with a sufficiently high output to provide good sensitivity.

As an example, a specific unit can provide 0.7 volts per 100 rpm with a starting torque of 0.15 oz-inches, or can produce 1.7 volts per 100 rpm with a starting torque of 0.5 oz-inches. Most units can be loaded to 50 milliamps depending on the winding.

Globe Industries, Inc.,
125 Sunrise Pl., Dayton 7, Ohio

Concentric High Ratio Capacitor

Recommending itself to those applications requiring a low minimum capacity high Q, and stability, a new concentric high ratio capacitor has a ratio of capacity of 35 to 1, and has applications in electronic equipment

where capacitive adjustments must be made over a wide range with good accuracy. The unit has a maximum capacity of 35 mmfd, and a minimum capacity of one mmfd.

The capacitor is now being used in 10-channel transceivers, and because of its construction of silver-plated brass and Pyrex glass, it is said to have good performance characteristics at the higher frequencies. It is a high Q condenser at and above 200 mc.

The Johanson Mfg. Corp., Boonton, N. J.

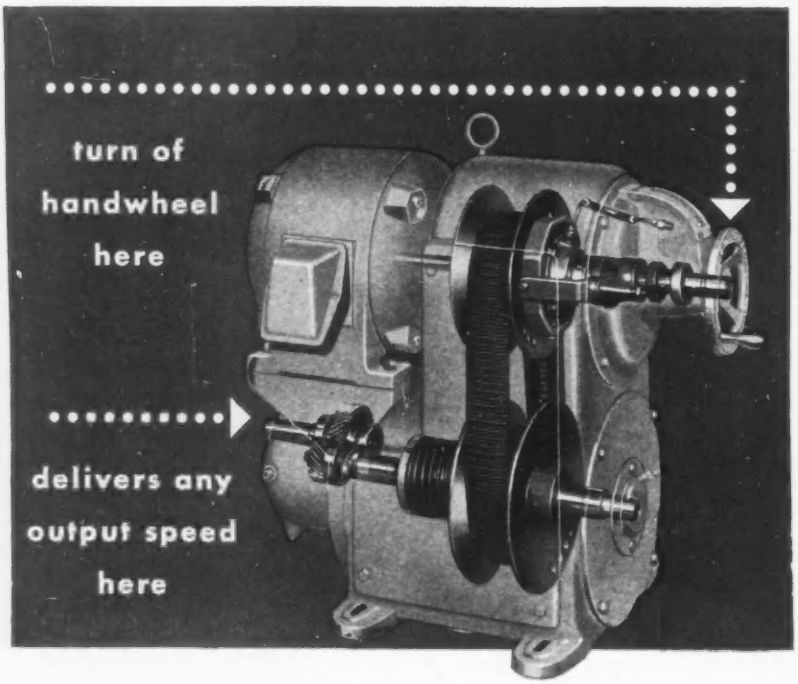
Line of Pre-Designed Magnetic Amplifiers

A new development in magnetic amplifiers, called Moto-Mags, permits engineers to select from a series of five "pre-designed" magnetic amplifiers, thereby fitting their plans to these units instead of designing magnetic amplifiers and other output stages to suit their specific requirements.

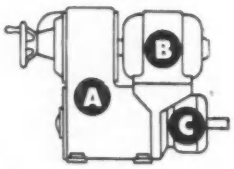
In place of the conventional output

How CONE-DRIVE gears improve your equipment
ALL TEETH IN CONTACT
45°
You can be sure, if the equipment you purchased is operated through Cone-Drive gears or speed reducers, that the manufacturer is giving you "the best."
The secret of Cone-Drive gears and speed reducers is their double enveloping action. Double enveloping—the worm wrapped around the gear, the gear wrapped around the worm—means far greater load capacity for a given gear size, amazing smoothness, greater shock load capacity, far longer life expectancy and trouble-free operation.
Ask if the equipment you buy has double enveloping Cone-Drive gears or speed reducers if you, too, want "the best at the lowest cost."
CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

Simplify your speed-changing methods with Reeves Vari-Speed Motodrive®



A complete, variable speed power plant in one, compact package that releases the *full* profit potential of every machine . . . every operator



REEVES Vari-Speed Motodrive incorporates (A) REEVES speed-changing mechanism, (B) any standard, constant-speed motor, and (C) gear reducer in a single, space-saving unit easily applied to any machine. Turn of handwheel or touch of button delivers any desired speed—instantly, accurately, *positively*—without stopping the machine. Widens machine work range; increases rate and quality of production; and utilizes highest skill of operator. Specify REEVES Vari-Speed Motodrives for the machines you build or buy. Sizes to 25 hp; speed ratios as great as 10 to 1. Send for free catalog to Dept. 21.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA
Recognized leader in the specialized field of variable speed control

REEVES Variable Speed Drives
for *accurate* speed control

transformer and power amplifier tubes, the new unit KP10-400 uses a phase sensitive vacuum tube, demodulator and magnetic amplifier output stage which eliminates the need for rectifiers, and is said to assure greater reliability.

Model KP10-400 operates from an input voltage of 115 volts, 400 cycles single phase; output is 10 watts reversible phase. KP10-400 operates from a —55 C to +70 C with minimum variation, and an input signal of 2 volts a-c or d-c working into a high impedance is required for a maximum of 110 volts, 10 watts, 400 cycles.

This magnetic amplifier unit is hermetically sealed and has a built-in power supply providing all plate and filament voltages to the demodulator.

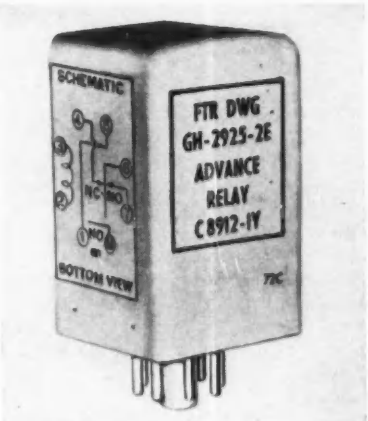
Model KP10-400 is 4 in. high and 3½ in. wide by 2½ in. deep. Weight of the entire unit is one lb, 13 ounces.

Keystone Products Co., 904 23rd St., Union City, N. J.

Ultra Sensitive Hermetically Sealed Relay

Designated series 4000, a compact, lightweight relay, has been designed for military requirements and applications in all types of ground and airborne communication equipment.

The single pole, single throw model is rated at 9 milliwatts, and the double pole, double throw model at 15 milliwatts maximum sensitivity.



The mounting is plug-in type octal plug or solder terminals. Coil resistance is available up to 50,000 ohms. Contacts rating: silver 1.5 amp., resistive at 24 V d-c; palladium 3.0 amp., resistive at 24 V d-c.

The unit is built to operate range at altitudes to 80,000 ft., through a temperature range of —65C to 85C. Rated at 10G vibration at 15 milliwatts.

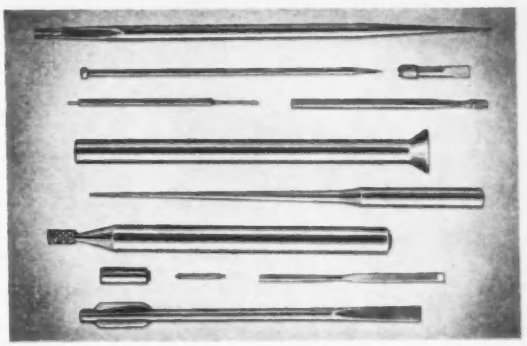
2435 N. Naomi St., Burbank, Calif. Advance Electric & Relay Co.,

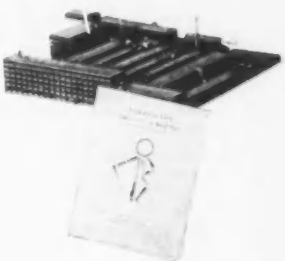
Torrington makes small precision metal parts . . .

better and faster at lower cost to you

For small precision metal parts . . . pins, pivots, punches, mandrels, needles, awls, blades, blanks, drills . . . made to your blueprints in any metal, call on TORRINGTON. Eighty-six years of experience with metals assure you quality parts *for less* than you can make them yourself.

The Standard Plant, home of the Specialties Division, has a daily output of eight to ten million precision metal parts. Automatic machinery of our own design enables us to fill your orders for 1,000 or 1,000,000 parts quickly, economically, and to the tolerances you require. Send us your blueprints for a prompt quotation.





Write for your free copy of our Condensed Catalog showing types and sizes of many special parts that can be produced *better, faster* and *cheaper* than you can make them in your own plant.

THE TORRINGTON COMPANY
Specialties Division
5 Field Street, Torrington, Conn.

Makers of
TORRINGTON NEEDLE BEARINGS

Greater Strength – Less Weight

Each element is made of the special steel alloy and subjected to the exact heat treatment required to provide the high *balanced* strength and light weight which characterize all

CURTIS UNIVERSAL JOINTS

Add to this precision design and simple construction, and you have the reasons why Curtis Universal Joints are the most durable, trouble-free joints available . . . for uses ranging from instrument controls to heavy steel mill applications.

ONLY CURTIS OFFERS ALL THESE ADVANTAGES

Availability – 14 sizes always in stock; bored or unbored hubs. 6" hub diameter joints or special machining to specifications.

Simplicity—fewer parts, simpler construction.

Government Tests – complete equipment for government tests in our plant.

Not sold through distributors; write direct for free engineering data and price list.

CURTIS

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE

SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Catalogs and Bulletins

(Continued from page 230B)

(38) ELECTRICAL PRODUCTS — Eagle Electric Mfg. Co. Catalog, 48 pp. Contains over 1400 electrical wiring devices, lamps and speciality products. Has full information on such products as: expansion and cord sets, fuses, lamps, wall plates, push buttons, range cord, and outlets, nichrome wire, and elements and staples.

(39) GATE VALVES — Edward Valves, Inc. Catalog 12-E, 6 pp. Complete information on a new line of cast steel gate valves, with details of design, material specifications, pressure and temperature ratings, and dimensional details and weights. Valves are in 300, 600, 900, and 1500 lb. sp classes, and in sizes from 2½ in. through 12 inches.

(40) FRAME TYPE CENTRIFUGAL PUMPS—Allis-Chalmers Mfg. Co. Bulletin 52B6691A, 4 pp. Cross section diagrams, engineering drawings, specifications, and operating curves for 3 types of frame centrifugal pumps having capacities up to 500 gpm and heads as high as 135 feet.

(41) PILOT BUSHINGS—J. G. Jergens Co. Booklet, 4 pp. Has cut-away illustrations, drawings, applications, dimension sketches, and specification tables describing a pilot bearing bushing, said to give an absolute seal against coolants and fine powdered dust and grit.

(42) OILERS & COMPONENTS—Eynon-Dakin Co. Catalog, 22 pp. Illustrates and gives complete engineering data on a line of HY-Car oilers, standard oilers, vents, caps, special tube forms, oil lines, and other assemblies.

(43) MECHANICAL RUBBER GOODS—Lavelle Rubber Co. Catalog MS52, 60 pp. Covers polymer characteristics and recommendations; molded goods; extruded goods; lathe cut goods; sheet stocks and die-cut goods; specialties; and mat and matting. Methods and design, standard and custom molded parts are discussed. Has large illustrations, engineering drawings, specifications, and a list of compounds used.

(44) ELECTRICAL PANEL BOARDS—Federal Electric Products Co., Booklet PD-500, 16 pages. Describes the advantages of the Stab-Lok panelboard system and circuit-breaker system, which permits the installation of an entire panel board by getting the correct size enclosure and the required number of one- and two-pole circuit breakers. Enclosures contain 4½ in. gutters for easy wiring with the whole interior removable to give a complete box accessibility. Polarity sequence provides complete flexibility for requirements up to 42 circuits.

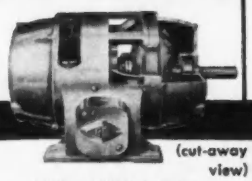
(45) SILICONES — Dow-Corning Corp., Booklet 2003, 32 pages. Describes the 200 Fluid, a plain, straight chain polymer, which is a bland clear oil having the advantage of retaining the same properties over a wide temperature span. It can be used as a defoamer and a polish ingredient, a release agent and a dielectric, a damping medium and a paint additive. Over 20 different properties from boiling point to sound transmission are discussed and illustrated. References are given, and a blending chart for intermediate viscosities is included. Many industrial applications are pictured and described.

(46) INDUSTRIAL INSULATION—Baldwin-Hill Co. Catalog J-1, 20 pp. Data on insulating materials covering the tempera-

DO THESE NEW

Reuland motors

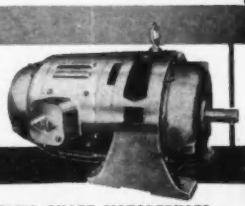
FIT INTO YOUR PICTURE?



(cut-away view)

FLUID-SHAFT MOTOR

Provides smooth acceleration of heavy loads. More compact than separate motor and fluid coupling. *Perfect alignment!* Thousands in use on cranes, mixers, centrifugals, etc.



FLUID-SHAFT MOTOREDUCER

This Fluid-Shaft motor and gear reducer combination converts the motor's conventional high speed into a slow speed, smooth starting, compact unit. Ideal for car pullers, conveyors, dryers, etc.

MAGNETIC BRAKE

The only brake that permits the use of TWO output shafts per motor. *When desired, the motor shaft can be extended right through!* Only 6 major parts...no levers or linkage... self adjusting . . . half usual length!

Write for new engineering folder on these and other *exclusive* Reuland Products... *industrial units designed to fill the needs of the nation's leading equipment manufacturers!*

REULAND ELECTRIC COMPANY

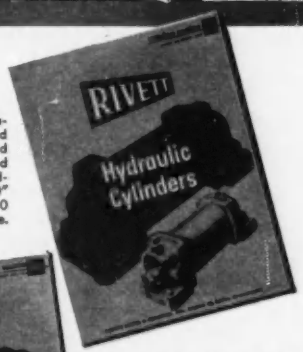
Alhambra, Calif. Representatives in all principal cities

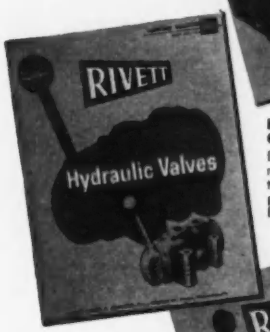
FIRST IN QUALITY . . . FIRST IN DESIGN

The sweetest story ever told—

on AIR and HYDRAULIC POWER!

Rivett Hydraulic Cylinder Catalog Section 105—
Details: Cushioned and non-cushioned, standard rod and 2:1 over-size rod, single and double end rod, internal and external threads, all standard mountings in 2" to 10" bores. Offered for 1500 P.S.I. 3000 P.S.I. available.





Rivett Hydraulic Valve Catalog Section 203—
Details: 4-way, 3-way, pilot, and remote valves in 6 types of operation, 4 types of action, 7 sizes, 5 piston designs. Offered for 1500 P.S.I. 3000 P.S.I. in most models.

These five books, totaling 68 pages, are jam-packed with all the important and necessary data required to lay out successful air and hydraulic circuits. Over 400 Rivett models, in a variety of sizes, are detailed — every standard air and hydraulic component offered in the industry. Description of each model includes working drawings, specifications, and cut-away views. All data pertaining to each model is shown on one page to facilitate layout. Easy to use, complete in information, these Rivett catalogs are a must on every board. Write to Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.

439 standard Rivett models described!

—All the necessary components for any efficient circuit.

Rivett Hydraulic Power Unit Catalog Section 400—
Details: Single, double and combination pump types. Single—.4 G.P.M. to 40 G.P.M. at 1000 P.S.I. Double—3.5 G.P.M. to 48 G.P.M. at 1000 P.S.I.

Rivett Air Cylinder Catalog Section 55—
Details: Cushioned and non-cushioned, single and double end rods, internal and external threads, 7 standard mountings in 1½" to 12" bores. Offered for 150 P.S.I. air and 300 P.S.I. oil services.

Rivett Lathe & Grinder, Inc., Brighton PE2 Boston, Mass. Please send me: ☐ Hydraulic Cylinder Catalog 105 ☐ Hydraulic Valve Catalog 203 ☐ Hydraulic Power Unit Catalog 400 ☐ Air Cylinder Catalog 55 ☐ Air Valve Catalog 303

Name _____ Company _____

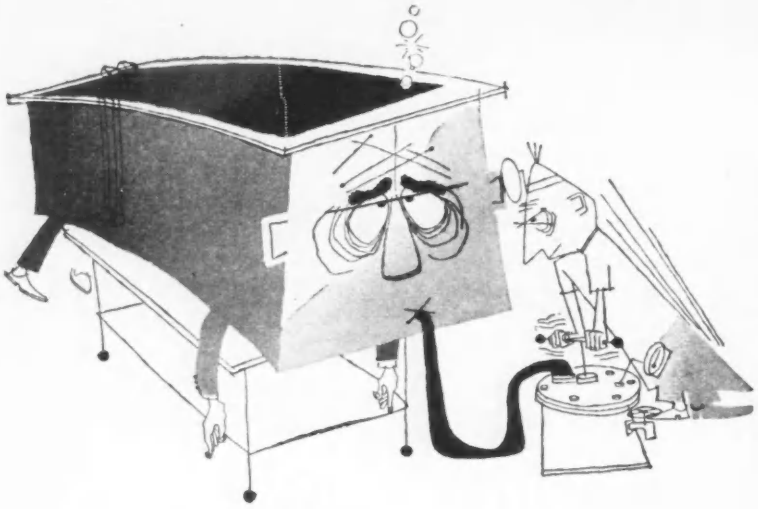
Address _____ City _____ State _____

Rivett Air Valve Catalog Section 303—
Details: 4-way and 3-way, pilot and remote valves in 5 types of operation and in 5 sizes. Offered for 150 P.S.I. service.

RIVETT furnishes a complete power package

VALVES ▪ CYLINDERS ▪ POWER UNITS

Air and Hydraulic
All sizes and types



has **coil-itis*** cramped your production flow?

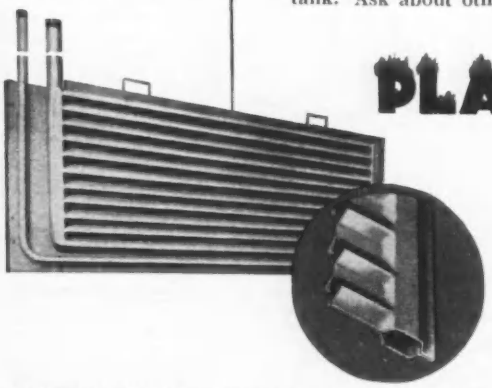
It's a waste of costly time to pump out the solution every time your process heating and cooling tanks get indigestion due to pipe coil troubles. You can save this cost and eliminate production bottlenecks by replacing the pipe coils with Platecoils. Platecoils can be removed and replaced **without dumping the solution.** They simplify maintenance and save hours of downtime. They heat or cool 50% faster and take 50% less space in the tank. As revolutionary as the new wonder drugs, Platecoils cure production troubles involving heat transfer . . . and give profits a shot in the arm.

Write for bulletin P77 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS TRIPLE PRODUCTION

At Continental Motors Corp., 3 crankcase sections can be cleaned at one time when Platecoils are used while only one crank case can be cleaned with pipecoils in the tank. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

*

Coil-itis — Diagnosed as tank heating and cooling problems. **Platecoils** — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, KOLD-HOLD MANUFACTURING CO., LANSING 4, MICHIGAN

ture range from −150 F to 1,800 F. Has thermal-conductivity graphs, and heat loss charts, plus applications, sizes, packaging, and densities.

(47) METALLIC SEALS—The D.S.D. Mfg. Co. Booklet, 3 pp. Describes the Toruseal, a stainless steel seal of seamless construction that may be used at temperatures from −150 to +1,000 F, and to pressures of 1,000 psi or more. A chart gives deflection characteristics, and illustrations suggest uses.

(48) ALUMINUM BUS BARS — Bulldog Electric Products Co. Bulletin B-750, 4 pp. States the features of aluminum as an electrical conductor. A chart lists how aluminum bus bars compare with copper in size, weight, and voltage drop. Also discusses mechanical strength, and maintaining contact pressure at joints.

(49) INSULATED WIRES—Minneapolis-Honeywell Regulator Co. Bulletin 5600, 2 pp. Containing engineering data and representative applications for each, the booklet describes three new thermocouple wires for use in temperatures varying from −20 to +2,000 F. Complete specifications given for each type.

(50) ATTENUATORS — The Daven Co. Booklet, 64 pp. The controls shown are: radio frequency attenuators, special units for precision measuring equipment, tone compensating attenuators, stereophonic controls and T, balance H, ladder and potentiometer type audio attenuators. Description, charts and many wiring diagrams given for each.

(51) PRECISION SWITCHES — Micro. Catalog 82, 24 pp. Covers safety, limit, and interlock switches for switching a-c circuits in industrial and commercial applications. Also includes: mechanical, and electrical characteristics, and capacities, and other information on: heavy duty precision limit switches, metal housed switches, and other sealed switches.

(52) STEEL SPECS. CHART—Peter A. Frasse & Co., Inc. Chart, 2 pp. Shows chemical analysis for each of 70 Military, Army, Navy, Aeronautical, and Federal specifications. Also listed are specified forms (sheets, bar, tubing, etc.) and nearest corresponding SAE, AISI, and AMS type numbers.

(53) MAGNETIC AMPLIFIERS—Westinghouse Electric Corp. Booklet TD-52-600, 18 pp. A section of the booklet is devoted to magnetic amplifier terminology. Next is an explanation of the theory of operation. Curves, tables, and wiring diagrams are in sections dealing with component parts, applications, and operating characteristics.

(54) TOROIDAL INDUCTORS—Lenkurt Electric Co. Bulletin TL-P4, 4 pp. Lists the precision wound, high Q toroidal inductors, with 5 types of coils available with or without hermetically sealed cases. Included are Q curves and other design data for representative standard values of the varied coil types. Inductance values between 1 mh and 80 H.

(55) MOTORS, CONTROLS, REGULATORS—Reliance Electric & Enginering Co. Bulletin A-2703, 4 pp. Describes and illustrates a-c motors from ¾ to 300 hp; electronic controls and regulators for this motor-drive system; and motor-generator sets, generators, and rotating-type regulators. Also shows heavy duty type T d-c motors from ¾ to 1000 hp.

(56) EXPLOSION-PROOF MOTORS — The Louis Allis Co. Bulletin 800, 12 pp. Fully illustrated, a line of explosion-proof motors is described, showing special features, typical uses, and various electrical and mechanical modifications available.

(57) VERTICAL MOTORS—U. S. Electrical Motors, Inc. Bulletin F1454-60M, 16 pp. Range of verticlosed motors extends from 1½ to 400 hp. Engineering data includes discussions of tandem bearings; dual balancing of rotors and the motor assembly; and use of automatic backstops. Single phase hollowshaft motors to 5 hp. Describes and illustrates new features.

(58) SET SCREWS—Set Screw & Mfg. Co. Catalog 16, 22 pp. Discusses a line of set screws, illustrating and giving complete specifications for each type. Those covered are: standard hexagon socket; Nu-cup set screws; standard slotted headless; fluted socket; hexagon keys; pipe plugs; socket head cap screws; stainless steel set and cap screws; self-locking set screws; and slabbed head setscrews.

GITS Unit* SEAL
Now STANDARDIZED

For . . .

Gear Reduction Units
Aircraft Reciprocating Engines
Automotive Accessories
Jet Propulsion Units
Washing Machines
Standard & Special Machine Tools
Electrical Power Equipment
Business Machines

If *you* have a shaft sealing problem, Gits experience in these and many other specific applications can prove of great and immediate value to you.

Write today for FREE illustrated Brochure, or send us your seal problem.

*Cartridge Seal . . . pressure balanced . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Ave. • Chicago 23, Ill.

Gits Lubricating Devices,
The Standard For Industry For Over 40 Years

AMERICAN CHEMICAL PAINT COMPANY
AMBLER PENNA.

Technical Service Data Sheet
Subject: *GRANODIZING** FOR LONG PAINT LIFE ON STEEL

"GRANODINE" FORMS A DURABLE PAINT BOND

Granodizing forms a crystalline, zinc phosphate coating on steel. This ACP paint-bonding process chemically changes the surface of steel into an inert non-metallic coating made up of thousands of microscopic zinc phosphate crystals.

Granodized steel thus presents a surface much more receptive to paint than untreated steel. Its crystalline structure permits a firm and durable "keying" or bonding of the paint finish. And the "Granodine" zinc phosphate coating itself is actually integral with the metal from which it is formed.

"GRANODINE" CAN BE APPLIED BY DIPPING, SPRAYING OR BRUSHING

Granodizing can be accomplished by:

1 Dipping the work in tanks;
2 Spraying the parts in a power washer; or
3 Brushing, spraying, or flow-coating the work with portable hand equipment.

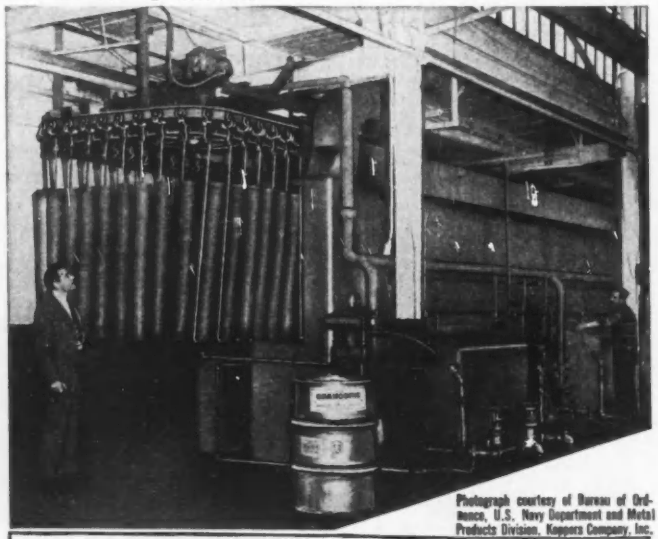
Choice of process is usually decided by such factors as the size, nature, and volume of production.

"GRANODINE" STANDARD PRACTICE ON BOTH CIVILIAN AND MILITARY PRODUCTS

Automobile bodies and sheet metal parts, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, tanks, trucks, jeeps, containers for small arms, cartridge tanks, 5-gallon gasoline containers, vehicular sheet metal, steel drums and, in general, products constructed of cold-rolled steel in large and continuous production are typical of the many products whose paint finish is protected by "Granodine".

In military production, "Granodine" is used to obtain a zinc phosphate finish meeting Grade I of JAN-C-490 and equivalent requirements of other specifications.

*"GRANODINE" Trade Mark Reg. U.S. Pat. Off.



Photograph courtesy of Bureau of Ordnance, U.S. Navy Department and Metal Products Division, Koppers Company, Inc.

Typical power spray washing machine for the automatic application of a protective phosphate coating to metal parts in preparation for painting. These 5" rocket motor tubes, as well as products made of cold rolled sheet steel, are effectively phosphate coated in such equipment.

CHEMICALS ACP PROCESSES

MEETINGS

February 27

MALLEABLE FOUNDERS' SOCIETY—Western Sectional Meeting, Hotel Drake, Chicago, Ill.

March 3-5

SOCIETY OF AUTOMOTIVE ENGINEERS—National Passenger Car, Body, and Materials Meeting. Sheraton-Cadillac Hotel, Detroit, Mich.

March 6

MALLEABLE FOUNDERS' SOCIETY—Eastern Sectional Meeting, Hotel Commodore, New York, N. Y.

March 9-12

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION—Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

March 16-20

NATIONAL ASSOCIATION OF CORROSION ENGINEERS—1953 Conference and Exhibition, Sherman Hotel, Chicago, Ill.

March 17-26

ROYAL NETHERLANDS INDUSTRIES FAIR—Utrecht, Holland.

March 18-20

AMERICAN SOCIETY OF TOOL ENGINEERS—Annual Meeting. Statler Hotel, Detroit, Mich.

March 23-26

INSTITUTE OF RADIO ENGINEERS—National Convention, Seminar, and Exhibition. Hotel Waldorf, Hotel Belmont Plaza, and Grand Central Palace, New York, N. Y.

March 23-27

AMERICAN SOCIETY FOR METALS—Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

March 25-27

SOCIETY OF AUTOMOTIVE ENGINEERS—National Production Meeting, Hotel Statler, Cleveland, Ohio.

March 27

MALLEABLE FOUNDERS' SOCIETY—Western Sectional Meeting, Hotel Drake, Chicago, Ill.

March 31-April 2

MAGNESIUM ASSOCIATION — International Magnesium Exposition, Washington National Guard Armory, Washington, D. C.

there's more to rubber than

Stretch

The most important factor about any rubber part is its ability to do the job for which it is intended. While the slingshot requires stretch only, industrial rubber parts must have resistance to oils, chemicals, weather, temperature extremes or combinations of these deteriorating factors.

STALWART engineers have the experience and facilities to compound stocks and fabricate rubber parts which will serve your needs best. From more than 500 different rubber stocks at their disposal they can mold, extrude, die-cut, lathe-cut or mandrel-build shapes to meet individual, S.A.E. or A.S.T.M. specifications. These parts will retain their desirable physical, chemical and dielectric properties under severe operating conditions and give optimum performance in each application.

Specify STALWART rubber parts for that one essential quality . . . the ability to do a job . . . best.

1184-SR

Write today for Catalog 51SR-1 for complete information.

STALWART RUBBER COMPANY

200 Northfield Road • Bedford, Ohio

Custom Engineered
MOLDED RUBBER PARTS

ACUSHNET specializes in "precision" molded rubber parts custom-engineered to specific requirements.

Utilizing the most modern techniques, our Engineering Staff constantly is developing new approaches to old problems, with notably successful results. By ingenious mold designing and skillful compounding, yesterday's skepticism of rubber for certain uses has changed to complete confidence in this versatile material as ideal for applications in countless vital assemblies.

Acushnet
PROCESS COMPANY

Consult our engineers on your next precision molded rubber job. In the meantime, send for a copy of the "Acushnet Rubber Handbook", a comprehensive rubber data reference for molded rubber parts.

Address all communications to 768 Belleville Ave., New Bedford, Mass.

Sans, Souci

Ad Libbing by the Editor

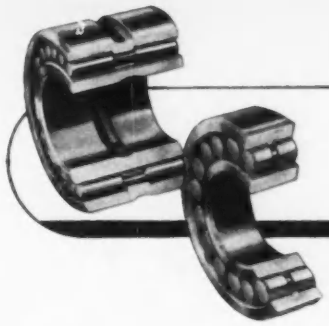
About six or seven months ago there was presented a paper at the Annual Convention of National Sales Executives in which the author made the following recommendations to sales executives so that they might qualify for "top level" positions in the corporate structure. Here are the recommendations:

"1) Live near the top officers and directors.
2) Spend recreation with the same social circle as the top officers and directors.
3) Cultivate the same cultural interests as the top officers and directors.
4) Maintain substantial civic activities.
5) Be interested in all phases of business.
6) Read both general business books and the classics.
7) Learn to make friends with, and utilize the abilities of, the capable—not the servile.
8) Be interested in helping others advance.
9) Be ever receptive to new ideas of all kinds.
10) Recognize that persuasiveness is needed to a less degree in administration than in selling—don't oversell yourself."

Many of the above items are open to a lot of discussion. They were presented at the meeting as the "ten roads to business success for the sales executives." In general, they apply equally well to engineers. The first three of the above suggestions can be rolled into one and all three covered by the one suggestion, namely, "Get in with the top officers and directors and their circle of friends, using every possible means to do so." Suggestion number four simply means that you should be a man who is well regarded in his community because of his participation in civic affairs.

The suggestion that the person should learn to make friends with and utilize the abilities of the capable might be open to lots of discussion, as to the meaning of the word "utilize". The suggestion to "marry the boss's daughter" was omitted, inadvertently perhaps.

Although not much fault can be found with the ten recommendations given above for the success of salesmen, it is highly significant that none of the ten suggestions have any relation to the individual's knowledge, background and abilities. Perhaps this is quite natural in the field of sales where personality, social connections, and sales ability are unquestionably the most important factors. In engi-



Over 33% Greater Capacity For The Same Size

There is a challenge facing manufacturers today to build smaller and more compact machines with extra precision and to combine more operations in each machine. This makes the selection of the proper bearings extremely important. A definite plus factor in this selection is the availability of a precision bearing that will deliver extra load carrying capacity in a minimum amount of space.

Obviously roller bearings, and particularly those of the small (needle) roller type occupy far less bearing space for equivalent capacity than ball bearings. Roller bearing capacity is built up in proportion to the effective race and roller contact provided. Thus a full type roller bearing *without space wasting cages* should provide the greatest capacity of any type of anti-friction bearing. However, to offer a perfect bearing the resulting full roller complement must be prevented from skewing and binding where misalignment occurs in the application.

The Guiderol bearing is the accepted answer to all these requirements considering precision, load capacity,

Bearing	McGill Guiderol No. GRI-209	Brand A Bearing	Brand B Bearing	Brand C Bearing	Brand D Bearing
Published Load Rating	8370 lbs.	6700 lbs.	7000 lbs.	5520 lbs.	6080 lbs.

Capacities at 2500 hours average life at 100 RPM

long life, versatility of mounting, and ease of lubrication. Published ratings show the Guiderol CT Series bearing has over 33% greater load carrying capacity than the average of the four highest rated interchangeable bearings. As a result, a Guiderol bearing at least one size smaller can often be substituted with the necessary shaft and housing requirements reduced in size and cost.

How Rollers Are Guided

In the Guiderol bearing design the grooved rollers with full race width contact are prevented from skewing by a center guide rail. Normally the rollers run on a true axis

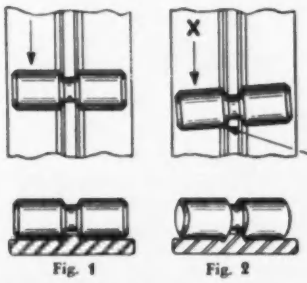
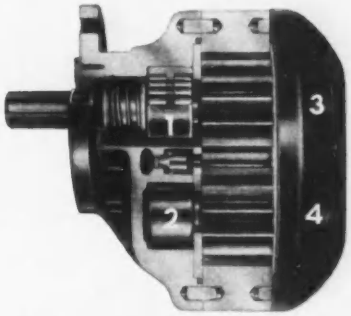


Fig. 1 Fig. 2

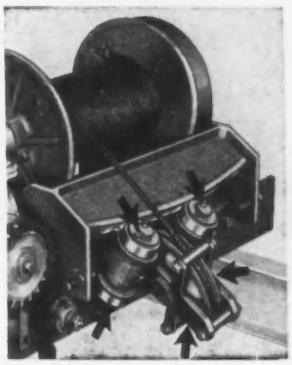
— not contacting the rail and thus need no correcting. (Fig. 1) Should misalignment cause a shift off center (Fig. 2) the leading end of the roller is retarded by contact with the rail at location Y. The trailing end catches up, relieving the rail contact, and the roller then resumes normal operation.

Typical GUIDEROL® Bearing Mountings

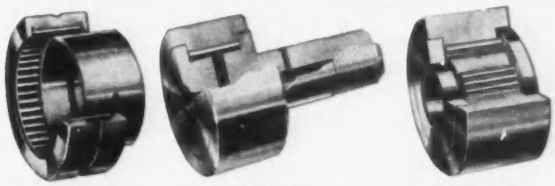


On a Hydreco Gear Pump Idler and Drive Shaft, 4 Guiderol bearings are used. The longer rollers of the Guiderol bearings are effective virtually to the edge of the races. This gives substantial support close to the gear and materially reduces shaft deflection.

Four Guiderol bearings support and guide an automatic spooling attachment across the face of the reel track on a 20,000 pound Gar Wood Reel-Lite Winch. The guided roller principle prevents skewing of rollers in the 4 vertically mounted bearings even with a 10,000 pound angular load per bearing. A fifth Guiderol bearing in the sheave provides added stability and eliminates binding due to off-center loading.



MULTIROL® Bearings



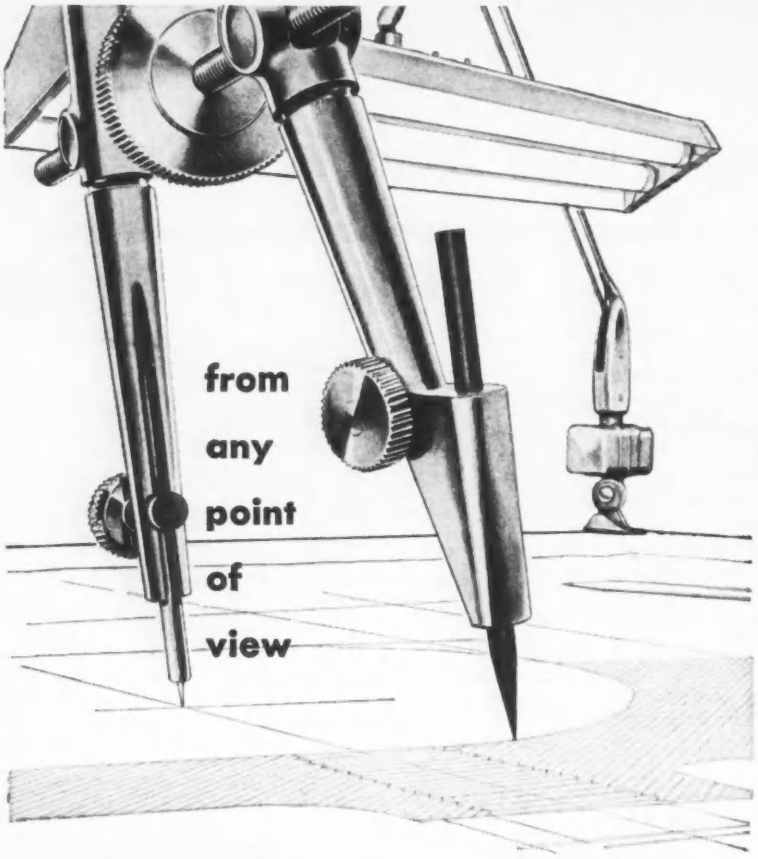
SE Series CF Series CYR Series

A new 140-page Bearing Reference Guide complete with 30 pages of vital engineering data has just been released by the McGill Manufacturing Company.

It has the full story on the advantages of Guiderol Bearings and in addition contains complete information on the well-known Multirol CF, CYR and SE Bearings. *Send now for your copy of the McGill Catalog No. 52.*

McGILL® — Precision Bearings

McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana



you'll get better results with ARKWRIGHT

First, the drawing and second, the reproduction will be cleaner, clearer, sharper when you use Arkwright Tracing Cloths.

In the drawing you'll work more smoothly, easily—without pinholes, uneven yarns or other imperfections to slow you. You'll get clean, "feather-free" lines even over an erasure.

In the reproduction you'll always have clear, "contrasty" results because Arkwright Cloth is *permanently* transparent—won't discolor or turn brittle and opaque with age like inferior products.

Are *you* interested in results like these? Specify Arkwright Tracing Cloths. Write for samples to Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

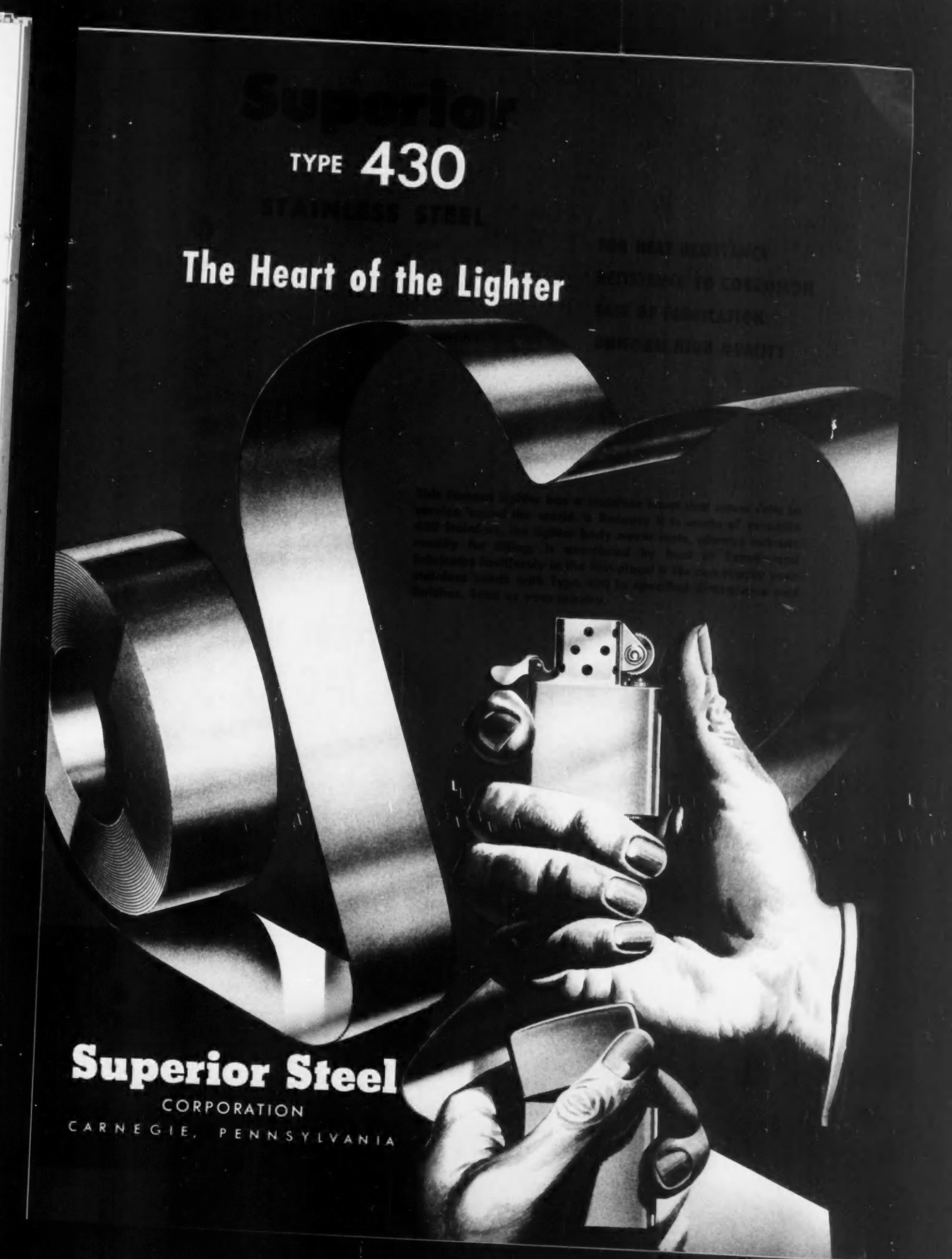
ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 30 YEARS

neering, however, there is the added requisite that the individual must possess a large fund of knowledge, many years of training and a keen mind capable of analyzing problems. Obviously the person possessing these attributes plus the ten that are enumerated above will get ahead quickest.

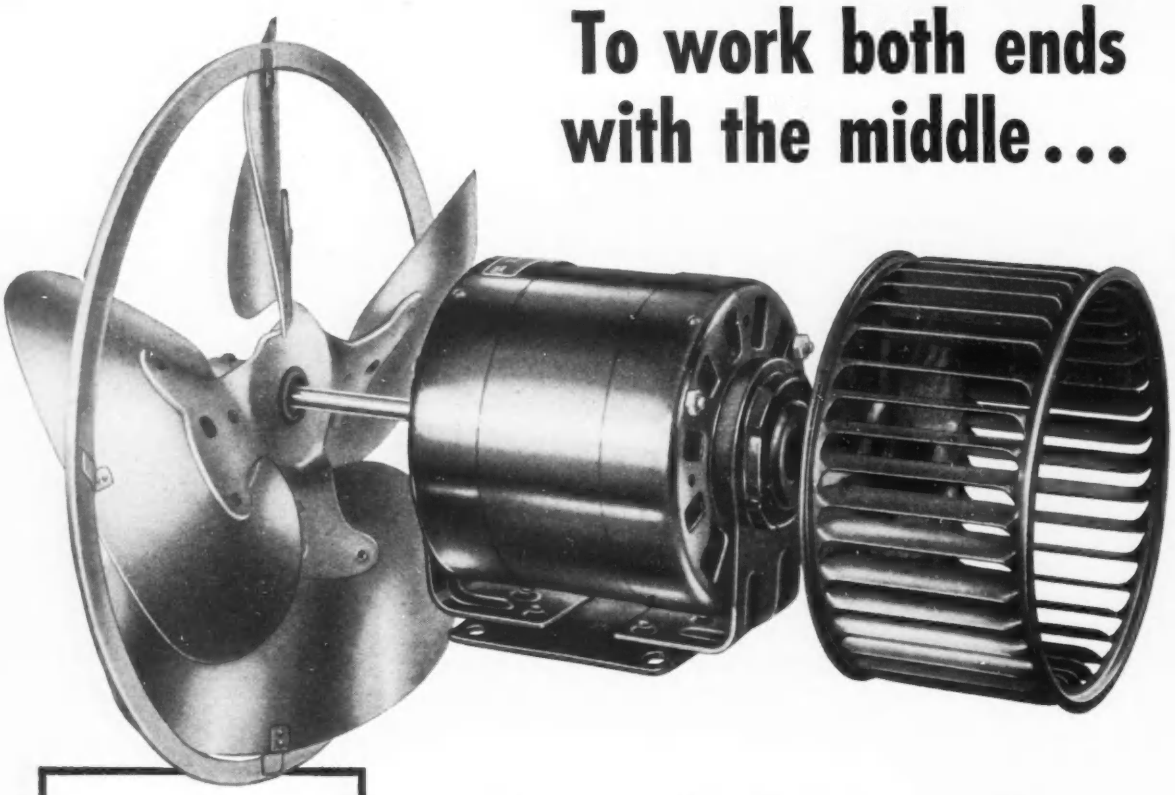
I am just wondering whether the fellow who wrote those ten recommendations for advancement and success in salesmanship ever read that little book called, "How To Succeed In Business Without Really Trying" by Mr. Edward Mead, Vice President of Benton & Bowles, Inc. Anybody who reads Mr. Mead's book should remember that, "Many a true word is spoken in jest". At any rate, although I just about split my sides laughing when reading Mr. Mead's book, I could not help but recognize that behind all of his suggestions Mr. Mead was presenting some fundamental truths. There is still a terriffic amount of hocus-pocus in American business and there probably always will be.

All of us have met the bright young boy who would rate one hundred percent on each of the ten items presented in the paper given at the annual convention of the National Sales Executives. Those young fellows will then wonder why it is that they have a terrific mushroom growth but wilt away as soon as the sun comes out. What I mean is that they go up the ladder of success with extreme rapidity but just about the time that they reach a great height and they begin to bask in the limelight, they suddenly shrivel away. In other words, people get wise to them and discover that they have all of the ten attributes to reach success but do not have that one essential ingredient that is required to remain successful. Namely, they cannot "deliver the goods".

And speaking about hocus-pocus, this reminds me of the editor who went down to Washington to pick up a story. He did not have much trouble getting the story from the public relations officer at one of the navy bureaus, or was it the army, but the story lacked pictures. So he asked the public relations officer for suitable glossies and he got the answer that he was not permitted to give out pictures because the pictures were still on the restricted list. The editor was very persistent. In fact he was so persistent that the public relations officer felt that he had to do something and finally handed the editor a package with the remark, "It is absolutely against the rules to give you the prints as they are on the restricted list. The best I can do is give you the negatives and here they are." Of course this is a rather far-


Superior
TYPE 430
STAINLESS STEEL
The Heart of the Lighter
Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

To work both ends with the middle...



A typical set-up for a room air-conditioner, with a 6-pole Fasco Motor (Model 3A) driving an impeller for positive air movement—and a propeller blade for cooling the condenser.

and work them well, use FASCO MOTORS

This application shows a modern shaded pole motor at its best.

There's power to spare (up to ⅛ hp) carried smoothly by a rugged ½" shaft. There's accurate balancing for vibration-free performance . . . and resilient mounting to keep the noise level very low. There's low speed (about 1000 RPM), speed that's controllable . . . and engineering that eliminates AC hum. There's precision in mechanical tolerances that assures long life and quiet operation. There's no interference with radio or TV reception. And there's real economy—despite the fact that Fasco Motors are engineered specifically for the job . . . and produced only after exhaustive study of the application.

Fasco engineers will be glad to work with you on your small motor problems . . . in your own plant if you wish. Just write.

FASCO
INDUSTRIES, INC.
ROCHESTER 2, NEW YORK

fetched story and I for one don't believe that any of our public relations men at any of our government bureaus would be quite as stupid as all that. But it is a cute little story to signify the fact that only too frequently people get terribly mixed up in their thinking.

Let's Look at the Record

It seems that a great many people have a love for record keeping. They want to keep a record of this and a record of that. Over the years they accumulate a terrific mass of information and misinformation. They pride themselves upon the completeness of their records but the great joke is that nobody ever looks at them.

Only recently I came across an outfit that was very proud of the complete coverage of their record keeping. As the big boss put it, "We can quickly tell you the answer to any question you might ask." His statement must have been true because it is inconceivable that the many filing cabinets full of information and statistics could be lacking in the answer to any question that might be asked concerning that particular business. Ironically, nobody ever asked a question, or at least the questions came at rather long intervals. The costly records had but a very small dollar volume; they were not worth keeping. And remember it may cost as much to look at a record as it does to make and keep it.

Once upon a time I had a man on my staff who perhaps had the makings of a record keeping hound. He came to me with a wonderful sounding suggestion about keeping a certain system of records and asked authorization to go ahead and get the necessary filing cabinets. I asked him to give me a detailed accounting of what it would cost to keep the records, the accounting to include the investment in the filing cabinets, the rent for the floor space occupied, the cost of typing the records, the cost of filing the records and finally the cost of looking at the records. Then I asked him to put down in dollars and cents how much money would be saved or gained by keeping these records. My next question was, "Well how much money do we lose annually by not keeping the records?" It developed that it would cost almost two thousand dollars per year to keep the records, whereas the possible loss in not keeping them was only a matter of a few hundred dollars. The young man saw the point and although he is no longer with us I know that he is not an addict for keeping volumes of records.

—G.F.N.

Long Life
in this clutch
Tough jobs—tough schedules—that's the picture cut out for portable air compressors. No time to stop and fuss with adjustments here ...too many operations depend on the compressor running steadily. That's why most manufacturers of portable air compressors specify Twin Disc Model SLT Spring Loaded Clutches. Developed by Twin Disc engineers working closely with leading compressor designers, Model SLT Clutches are built with a wide margin of safety —constructed for positive drive, free from burning and slippage. As a result, operators refer to these Twin Disc units as "the clutch you can install and *forget* about."
Twin Disc Spring Loaded Clutches *are* dependable and rugged—but there's another important factor. *Sixty* Twin Disc Parts Stations—*eight* Factory Branches—and a $3¼ million circulating parts and complete unit inventory add up to the fact that *you* can install a Twin Disc Drive and forget it—but *Twin Disc does not.*
A Twin Disc Model SLT Spring Loaded Clutch—designed for extra-heavy duty—provides the power link in this Le Roi 315D Airmaster compressor with wagon drill, at work in a quarry near Waukesha, Wisconsin. Engine is an International UD-18 Diesel.
Built for a Long Life . . .
Backed for
a Lifetime
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois
BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

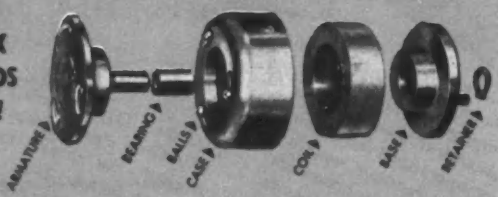
LEDEX ROTARY SOLENOIDS

...give positive, powerful snap action!

here's how a LEDEX ROTARY SOLENOID operates...

The magnetic pull moves the armature along the Solenoid axis. This action is efficiently converted into a rotary motion by means of ball bearings on inclined races. The inclined ball races are made to compensate for the magnetic pull increase as the Solenoid air gap closes, thereby providing substantially constant torque throughout the Solenoid stroke. The rotary snap-action power of the Ledex can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models.

here's why LEDEX ROTARY SOLENOIDS are dependable!



As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled.

The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space . . . giving tremendous power to compact Ledex Rotary Solenoids.

six basic LEDEX ROTARY SOLENOIDS to choose from!

Model Number	2	3	5	6	7	8
Diameter	1⅛"	1⅝"	1⅞"	2¼"	2¾"	3⅜"
Torque lb.-in.*	¼	1	5	10	25	50
Weight lbs.	⅛	⅛	½	1	2⅛	4¼

*45° stroke intermittent duty.

Engineering data is available upon request. Write for descriptive literature today!

G. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO

ENGINEERING ABSTRACTS

Sub-Zero Technique In Engineering

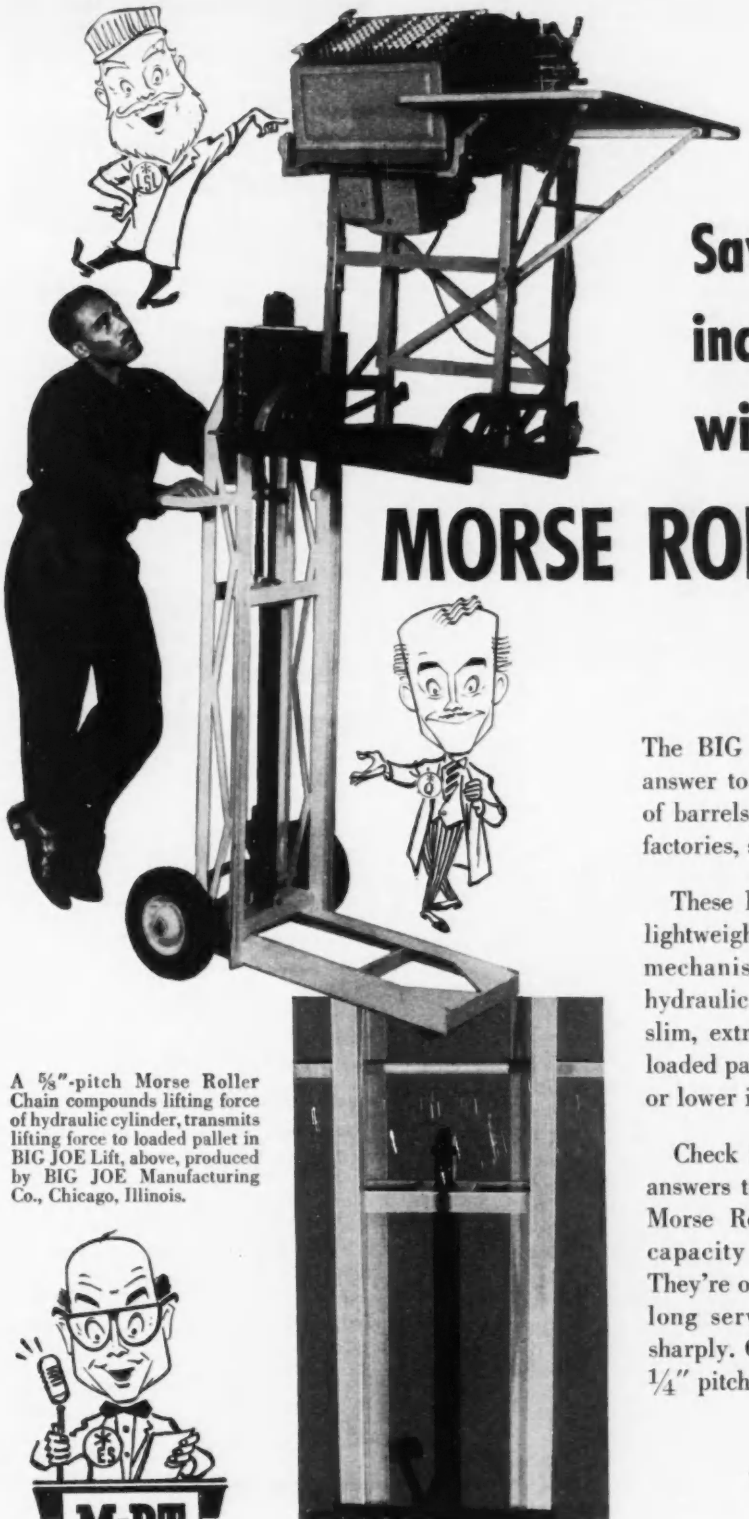
Abstracted from "Sub-Zero Technique in Engineering," by R. H. Warring, *Mechanical World*, September 1952.

THE STABILIZATION OF METAL used for gages arbors, mandrels and other precision machine parts is important in production since any metal component which must hold its physical dimensions to very close tolerances must be aged if the tolerances are not to be exceeded in the course of time by natural growth and warping of the material. While natural aging produces the desired result in the end, the time factor involved makes it impracticable. Without aging, and where extreme accuracy is of vital importance, constant checking and reworking may be necessary. As an example, lapping plates and surface plates used in gage block manufacture stabilized by "quick" methods have often to be resurfaced every two or three hours.

In the case of steel, stabilization consists of transforming austenite to martensite. By ordinary heating and quenching methods, only a proportion of austenite is changed into stable martensite. The transformation can then continue over a period of years, slowly but inevitably. During that period the physical dimensions of that piece of steel are subject to variation.

The seasoning and stabilization of metals are but two of the many industrial applications of sub-zero temperature machines. They are, for example, widely used for the shrinking effect they have on metals. Shrink-assembly, where the male part of a close fitting assembly is chilled and shrunk in size for ease of assembly, offers many advantages over the conventional methods such as heating, pressing or force-fitting. Chilling has no appreciable effect on the parts themselves, other than a reduction in physical size, so that no additional finishing steps are required. Parts can readily be assembled by hand, to result in a tight fit as soon as they return to room temperature. There is no risk of oxidation, as might be present where the female part of a tight assembly is heated to expand to fit, and the chilled parts are far more easily handled than heated ones.

The normal industrial sub-zero tem-



A ⅝"-pitch Morse Roller Chain compounds lifting force of hydraulic cylinder, transmits lifting force to loaded pallet in BIG JOE Lift, above, produced by BIG JOE Manufacturing Co., Chicago, Illinois.

Save weight, space; increase service life with

MORSE ROLLER CHAINS

The BIG JOE lift truck line is a low-priced answer to the loading, unloading, and stacking of barrels, boxes, bags, crates, coils, and dies in factories, stores, and warehouses.

These lift trucks are compact, yet powerful, lightweight, easily maneuvered by one man. Lift mechanism is actuated by small, heavy-duty hydraulic unit which transmits power through slim, extra-strong Morse Roller Chain to move loaded pallet quickly up to 54" maximum height or lower it quickly and safely.

Check into Morse Roller Chains for possible answers to your power transmission needs, too. Morse Roller Chains provide you with high-capacity power transmission in small area. They're over 99% efficient. They give unusually long service life, reduce maintenance costs sharply. Complete range of sizes available from ¼" pitch to 2½" pitch. Write for catalog today.

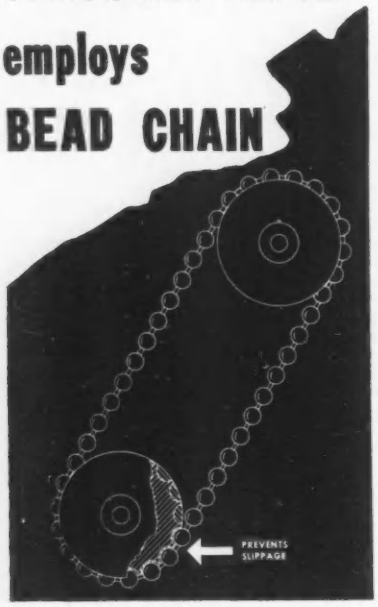
✻ Quality, Engineering Service, Long Service Life—which you get in unusual degree when you specify Morse Power Transmission Products.

MORSE CHAIN COMPANY

Dept. 580 • 7601 Central Avenue • Detroit 10, Michigan

MORSE
MECHANICAL
POWER TRANSMISSION
PRODUCTS

EFFICIENT, LOW-COST SPROCKET-DRIVE employs BEAD CHAIN



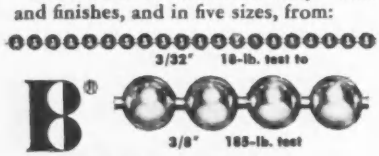
Because of its unique characteristics, Bead Chain is frequently employed by alert designers to make a simple, low-cost and highly efficient sprocket drive. Ideal for many products, it has been proved on business machines, television tuners, venetian blinds, etc. Slippage is absolutely prevented as each bead fits into an individual pocket.

Just check the qualities you want in a drive chain against the qualities offered by Bead Chain: It will not kink, bind, jam or shrink. It is completely flexible, strong, light, rustproof and long-wearing. Because every bead acts as a universal joint, changes in direction of pull are easily made.

SOLVES MANY DESIGN PROBLEMS

BEAD CHAIN — the chain you think of first as an electric light pull is truly "the Kinkless Chain of a Thousand Uses" — serving many industries and solving a wide variety of design problems. It may pay you well to check your product for opportunities to reduce costs and add sales appeal with this unique chain.

Bead Chain is available in many metals and finishes, and in five sizes, from:



The BEAD CHAIN® Mfg. Co.

92 Mountain Grove St., Bridgeport 5, Conn.

Manufacturers of: **BEAD CHAIN** — the kinkless chain of a thousand uses, for fishing tackle, novelty, plumbing, electrical, jewelry and industrial products; **MULTI-SWAGE** — the most economical method of producing small tubular metal parts for electronic and mechanical applications.

perature of minus 120 F produces a contraction of dimension equivalent to that obtained by about 200 F rise in temperature. Conservative values are a shrink of 0.001 in. per in. dia on steels; 0.0015 in. per in. dia on brasses and bronzes; and 0.002 in. per in. dia on aluminum and magnesium.

Where small diameters are involved (under 2 in. dia) the reduction in dimensions possible by cold treatment may be insufficient and moderate heating of the external part of the assembly is also used. Common methods employed are hot oil, hot water or hot air blast or, for greater expansion, magnetic induction heating. In general, where cold treatment has replaced the older methods, greater speed, efficiency and economy of operation has resulted.

Other fields encompassed by industrial chilling machines include the testing of metals and other materials at extremes of low temperature. This has been particularly useful for obtaining data on the behavior of rubber, plastic and similar parts used on high-altitude aircraft. At stratospheric heights, such parts may be subjected to continual low temperatures of the order of minus 20 to minus 100 F. It has been found, too, that close fitting aircraft parts machined in the normal manner have failed by seizing at high altitudes (low temperatures). Such failures have been overcome by "soaking" the partly finished components at minus 150 F in an industrial machine and then finishing to required size. These parts then continue to function satisfactorily under the most adverse conditions.

Sub-zero temperature "soaking" has also been found to improve the magnetic properties of many steels. A typical batch of magnet steel chilled for a period of 4 hr at minus 120 F, subsequently reheated to 300 F, cooled and magnetized showed markedly improved properties to the same steel magnetized in the ordinary way without cold treatment. Sub-zero technique has also been extended to other, diverse industries with equal success, embracing the fields of chemicals, metallurgy, paint and plastic manufacture.

Hot Radiography

Abstracted from "Hot Radiography Cuts Inspection Time" by Alexander Gobus, Metallurgist, Sam Tour & Co., New York. *The Welding Engineer*, November, 1952.

INDUSTRIAL X-RAY FILM is vulnerable to temperatures higher than 100 F. Hence weld metal must be cooled to that temperature before radiographs can be taken. In the case of heavy

Important SAVINGS to VOLUME users of small parts

..like these

thanks to **MULTI-SWAGE**

If you need small tubular metal parts like these in large VOLUME, Bead Chain's MULTI-SWAGE Process can mean important savings to you.

Much Cheaper Than Solid Pins

Many prominent users of solid pins for electronic and mechanical purposes have cut costs by switching to Multi-Swaged *tubular* pins . . . without sacrificing strength or accuracy.

Typical Applications—

As terminals, contacts, bearing pins, stop pins, male-female connections, etc., in a wide variety of products such as Business Machines, Ventilator Louvres, Toys, Radio and Television Apparatus, Terminal-boards, Electric Shavers, Phonograph Pickups, etc.

Send part (up to ¼" dia. and to 1½" length) and your specs for a quotation or write for DATA BULLETIN.

THE BEAD CHAIN® MFG. CO.

92 Mountain Grove St., Bridgeport 5, Conn.

Manufacturers of BEAD CHAIN — the kinkless chain of a thousand uses, for pull and retaining chains and other industrial uses; plumbing, electrical, jewelry, fishing tackle and novelty products.

1,000,000

INDUSTRIAL ENGINES

built in ONE year

It's a new world production record — never before accomplished. For 33 years BRIGGS & STRATTON has been establishing a long list of firsts. And now, in 1952, another is added.

BRIGGS & STRATTON is recognized as the pioneer and the leader in its field . . . setting new standards, year after year in engineering, in design, in engine performance and in precision mass production.

Whether you are a manufacturer, dealer or user of gasoline engine powered equipment — you are assured of top performance when you specify BRIGGS & STRATTON 4-cycle, single cylinder, air-cooled engines. They are the "preferred power" value all over the world.

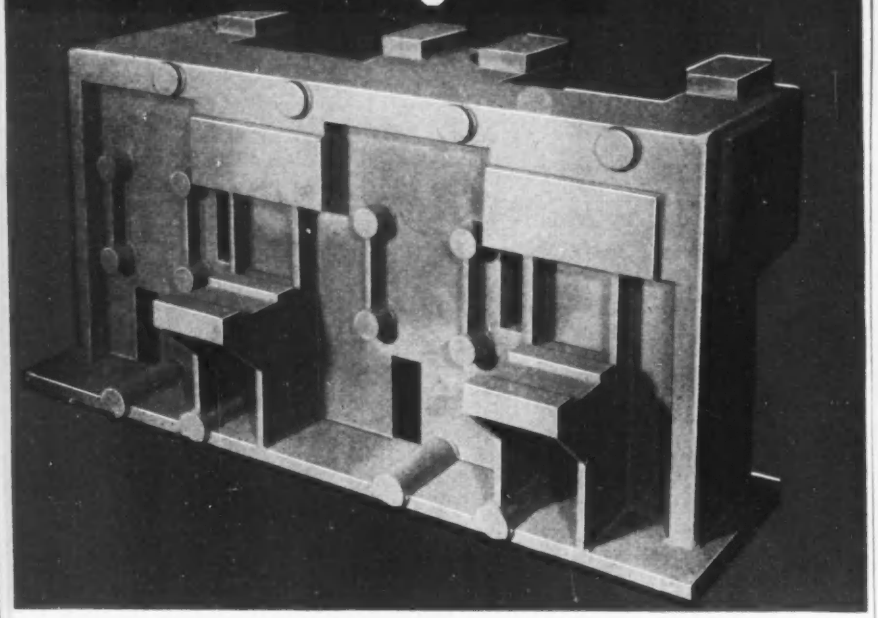
BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U.S.A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

BRIGGS & STRATTON 4-cycle, single cylinder, air-cooled engines are available from ¾ to 8¼ hp. — in many models and types. They are preferred power for hundreds of types of machines, tools and appliances. All are backed by a world-wide service organization, factory supervised, unequalled in the industry.

In the automotive field, too, Briggs & Stratton is the recognized leader — and the world's largest producer of locks, keys, and related equipment.

use castings?



WELDMENTS
CAN SAVE YOU MONEY!

Acme weldments are replacing castings for leading machinery and equipment manufacturers everywhere because they do a better job at lower cost. Experienced Acme engineers at work with Acme's complete fabrication facilities can give *you* these same advantages . . . Acme's new 24-page, illustrated booklet shows you why. *The Facts about Weldments and Castings* tells you what you should know about their relative strength, rigidity, vibration, design flexibility, and cost . . . facts to help you specify and save. And it's yours for the asking . .

ACME
TANK and WELDING
DIVISION of THE UNITED TOOL & DIE CO.
1039 New Britain Ave. • West Hartford 10, Conn.

- A.S.M.E. Qualified Welders
- National Board Approved
- Hartford Steam Boiler Inspection Service
- A.P.I. Approved
- Underwriters Label and Inspection Service
- Navy Approved

Write for yours TODAY!

pipe sections and with certain types of alloys, this means a long process of post-weld stress relieving before the cooling can even begin. Then, after the cool weld has been radiographed, several more hours of preheating are necessary before welding can be resumed.

A new "hot radiographic" technique known as the McElroy-McNutt process (licensed exclusively to Sam Tour & Co., Inc.) offers striking advantages when it is applied to alloys that would otherwise require a post-heat, controlled cooling and preheat cycle for each radiographic inspection. As a result, the total time required to weld pipe joints in high-temperature pipe lines is reduced by approximately 55 percent.

The new method does not require a different type of X-ray film. It uses the same film as before, but the film is protected by a water-cooled jacket. This consists of two hollow semi-cylinders hinged to each other at one end and fitted with wing-nut fasteners at the other. When a radiograph is to be taken of a hot pipe weld, the jacket is placed between induction coils and clamped around the pipe. Water is allowed to circulate for several min-

Hours Required to Weld 17-in. Steel Alloy Steam Pipe

Conventional Radiography	
Preheat	3
Weld first ¾ in. (5 passes)	9
Postheat and cool	32
Radiograph and develop film	3
Preheat	3
Weld to 1¾ in. (14 passes)	10½
Postheat and cool	32
Radiograph and develop film	3½
Preheat	3
Finish welding	27½
Postheat and cool	32
Grind overlay	3
Final radiography	3½
Total hours	165

Hot Radiography	
Preheat	3
Weld first ¾ in. (5 passes)	9
Hot radiography	½
Weld to 1¾ in. (14 passes)	10½
Hot radiography	1
Finish welding	27½
Grind overlay	3
Final hot radiography	1
Postheat	15
Total hours	70½

A Guide—for MAGNET WIRE Insulation Removal

TYPES OF WIRE AND STRIPPING METHODS

Type of Winding	DCC	Glass	EC	Formvar-Cotton	PE	HF	HNC	Method of Stripping
Motor Stators	x	x	x	x	x	x	x	Brushing
			x	x	x	x	x	Brushing & Burning
	x		x	x	x	x	x	Welding
						x	x	Chemicals
	x	x	x	x	x	x	x	Scraping
Wound Armatures	x	x	x	x		x	x	Brushing
Wire sizes				x		x	x	Burning & Brushing
8-20 AWG						x	x	Chemicals
						x	x	Scraping
Wound Armatures					x	x	x	Brushing
Wire sizes						x	x	Burning
21-30 AWG						x	x	Hot Solder
					x	x	x	Chemicals
Wound Armatures					x	x	x	Brushing
Wire sizes						x	x	Burning
31-40 AWG						x	x	Chemicals
					x			Sanding

Type of Winding	Paper DCC	Glass	°HNC Form. Cotton	PE	°HNC HF	°Nylon °Celen	Nylon Celanese Over °Nylon °Celen	Nylon Celanese Over HF-°HNC	Silk Over HF-°HNC	Silk Over PE	Method of Stripping
Transformers	x	x	x	x	x						1. Brushing
(large)			x		x						2. Burning & Brushing
&	x		x		x						3. Welding
Solenoids					x						4. Hot Solder
(large)				x	x						5. Chemicals
				x	x						6. Scraping
Transformers				x	x			x	x	x	1. Brushing
(small)					x						2. Burning & Brushing
&					x			x			3. Hot Solder
Solenoids						x	x				4. Soldering Iron
(small)				x	x						5. Chemicals
				x	x						6. Scraping or Sanding

°Nylon = Nylenamel
EC = Enamel Cotton

°Celen = Celenamel
HF = Formvar

° HNC = Nylclad o Formvar-Nylon coated wire
PE = Plain Enameled Wire, Beldenamel

Hot Solder:—This method is well adapted in many applications for removing Nylclad or Formvar films with or without nylon or celanese textile covering. The leads are tinned and ready to solder after this operation. Sizes 21 to 30 AWG represent a range that is best adapted for this method. The high surface tension and temperature of the hot solder, the tendency for the solder to amalgamate and reduce the size or embrittle fine wire leads usually limits the usefulness of this method to the intermediate wire sizes shown.

A 50-50 lead-tin solder bath is used generally, at a temperature of approximately 500°C or higher. The tin percentage, after the bath has been used for sometime, will decrease. Tin additions must be made therefore from time to time as dictated by experience.

Some formulations of Formvar films are not uniformly removed by the hot solder method and erratic results sometimes are encountered. Formvar nylon combination coatings such as Nylclad can be removed consistently.

Brushing:—For large wire sizes with insulations such as cotton glass (with or without plain enamel, Formvar, Nylclad), Formvar, Nylclad, plain enamel, revolving steel wire brushes are in general use for stripping apparatus leads.

For finer film coated wire, glass fibre brushes are being increasingly used. In the case of fine wires, steel wire brushes tend to scratch the copper and embrittle the leads whereas glass fibre brushes remove the insulation with a burnishing action and have practically no injurious effect on the copper itself.

Burning:—Equipment has been developed and is being used especially for stripping wound motor armature leads that first removed the insulation by burning. Copper oxide thus formed is next removed by brushing.

Welding:—Lead wires and coil leads frequently are welded. A small high-temperature gas flame is applied to heat the spliced lead to a temperature that just melts the copper. This method is used extensively for medium and large motor stator coils. In this operation, of course, all the film coating and textile is burned off.

Chemicals:—There are many proprietary compounds in general use for stripping film-coated magnet wire. They have one property in common. All are evil smelling and injurious to the skin. Care must be exercised therefore in handling these materials, and for some the use of a ventilated enclosure or hood is mandatory.

Soldering iron and low-temperature solder pots:—Celenamel and nylon film-coated wires are in general use, particularly in the radio and television industry. Both materials being thermoplastic can be removed by using a rosin alcohol flux and the application of a soldering iron, or dipping in 650°F lead-tin solder.

Reprints of this table for shop use available on request.

Belden MAGNET WIRE

BELDEN MANUFACTURING CO.
4691 West Van Buren Street, Chicago 44, Illinois

TEFLON* CAN *improve your products!*

JOHN CRANE — The best in TEFLON

Exceptional qualities of "JOHN CRANE" TEFLON make it highly desirable for a wide range of equipment and parts lines. Manufacturers of precision equipment and component parts cannot overlook its remarkable electrical, thermal, mechanical and anti-corrosive advantages. Note Teflon's outstanding properties and characteristics.

*DuPont Trade-mark for tetrafluoroethylene resin

Low power factor high dielectric strength

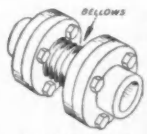
ELECTRICAL PROPERTIES: Power factor less than 0.0005 over the entire spectrum from 60 cycles to 30,000 megacycles, with a dielectric constant of between 2.00 and 2.05 • Short-time dielectric strengths from 1,000 to 2,000 v., per mil in thickness of 5-12 mils • High resistance to surface arc • Volume resistivity greater than 10^{15} ohm-cm • Surface resistivity drops to only 10^{13} ohms at 100 percent relative humidity.

Corrosion resistant

ANTI-CORROSIVE PROPERTIES: Resists all chemical liquids and gases except molten alkali metals and fluorine and chlorine trifluoride • No detectable changes in properties over 1-year outdoor weather test • Zero water absorption.

Outstanding thermal characteristics

THERMAL AND MECHANICAL PROPERTIES: Tensile strength 1,500 to 2,500 psi. at 77 deg. F. • Durometer hardness 55 to 70 • Stiffness 60,000 psi. at 77 deg. F. • Friction coefficient against polished steel (static) .09—.12 • Remains flexible down to −94° F. Serviceable up to +482° F.



Typical Application

TYPICAL APPLICATIONS: For such applications, as vhf, uhf, or high voltage—high temperature insulator forms, heat-resistant linings, oil and firewall seals, gaskets, valve discs or seats, packings, flexible bellows, diaphragms, slot liners, heat sealer jaws and dough rollers. Let our engineers fit "JOHN CRANE" TEFLON to your specific needs.

*"JOHN CRANE" TEFLON parts can be manufactured to your specifications. Investigate now. Let us know your requirements. Send for our 12-page illustrated catalog. Crane Packing Company, Dept. PE, 1845 Cuyler Ave., Chicago 13, Ill.

JOHN CRANE

CRANE PACKING COMPANY

utes before the film holders are fastened into place and the film exposed. Welding is continued as soon as the exposure is completed.

The whole operation is conducted at preheat temperature, and welding need be interrupted for only 30 min to an hour, depending on the thickness of the weld and the exposure time required.

The table shown above compare the old and new techniques. In each case, radiographs were taken at two intermediate positions. The first set was taken after $\frac{3}{4}$ in. of weld metal had been deposited; the second set after $1\frac{3}{4}$ in. The reason why the amounts of deposit differ is that flaws are most likely to occur near the root of a weld so that early inspection is advisable. A final radiographic inspection was made after all welding had been completed.

Raised sides on the jacket help to maintain an even temperature distribution along the surface and also provide a snug resting place for the film holders. These are held in place with heavy rubber bands.

The radioactive material is held at the center of the pipe by a special jig. The arm of the jig fits through an opening near the weld. When the joint is completed, a plug of the same alloy as the pipe is screwed into the opening and welded to the outer pipe surface.

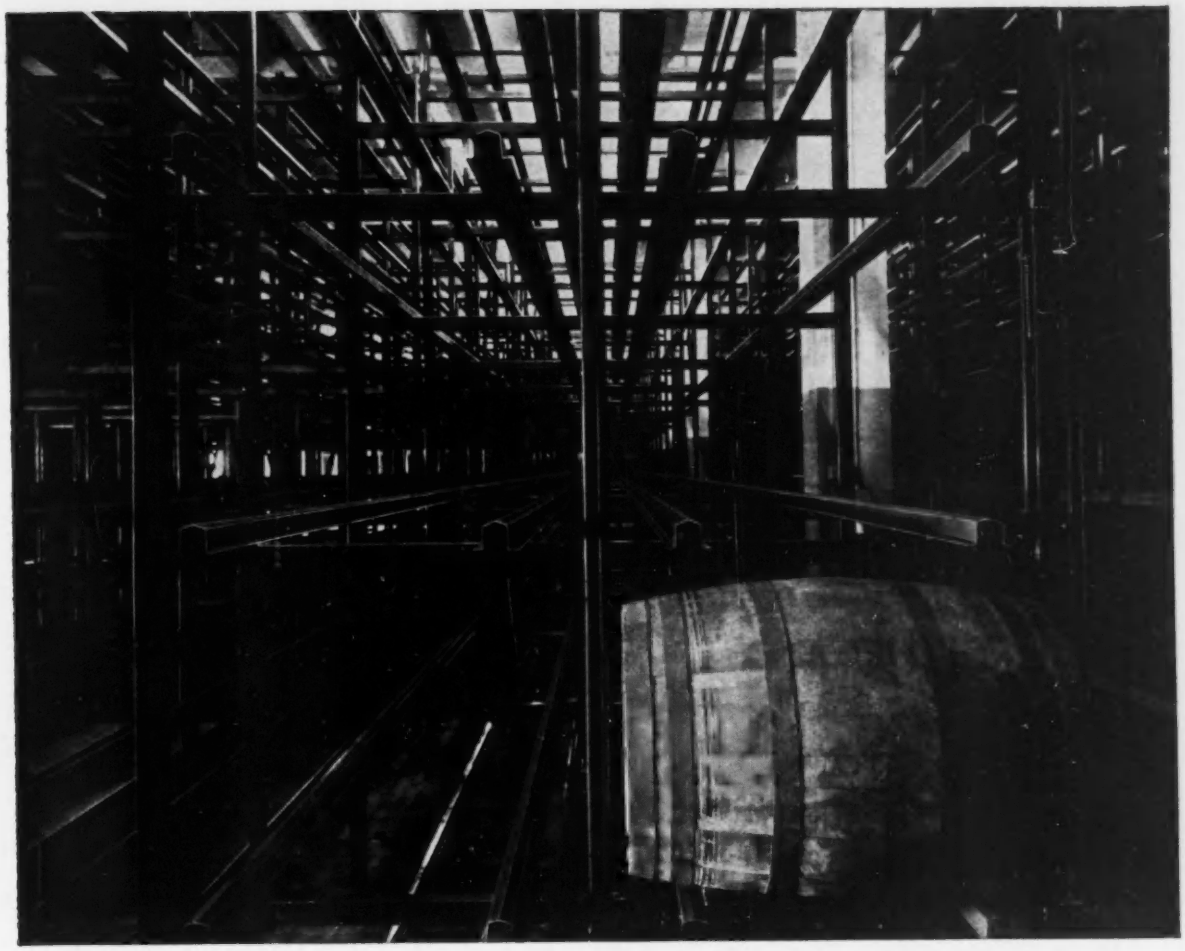
The use of the cooling jacket increases the distance between gamma-ray source and film by approximately $\frac{1}{2}$ in.; it also introduces two thin sections of steel before the film and adds a layer of water that must be penetrated by the radiation. None of these factors has had observable effect upon the radiographs. Penetrameter sensitivity with the new method is at least two percent. This accuracy is equal to that of the conventional method and is easily within the requirements of the ASME Power Boiler Code. (Paragraph P 102).

The principles of the new process have been used with similar time-saving results on welding jobs other than pipe. Special cooling fixtures can be designed for surfaces that are not cylindrical.

Sprayed and Sintered Parts

Abstracted from "Spray and Sinter to Make High Temperature Alloy Parts," by J. E. Cline, R. T. Thurston and John Wulff, Dept. of Metallurgy, Massachusetts Institute of Technology, *The Machinist*, May 10, 1952.

METAL-SPRAYING, heretofore used almost entirely for coating and surfacing, can be considered as a forming



190 miles of Cold-Formed Shapes

Barrels roll smoothly on this storage-rack maze—on a million feet of Bethlehem Cold-Formed Shapes! We fabricated sturdy 13-gage steel for the job, a new warehouse near Philadelphia, and cut the shapes in lengths up to 25 ft.

Storage racks are only one example of the growing variety of parts and products made from Bethlehem Cold-Formed Shapes. Manufacturers in widely separated fields are continually coming up with new ways of using these versatile shapes to good advantage.

Bethlehem Cold-Formed Shapes are made from steel sheets, strip or plates. Users like their uniform thickness, excellent strength-weight ratio, and relatively scale-free surface. What's more, Cold-Formed Shapes mean lower fabricating costs because they handle, weld and assemble so readily. We make them on presses, brakes or rolls in all gages from 5 to 24.

In analyzing your shop operations, perhaps you'll find a new use for Cold-Formed Shapes. Bethlehem engineers have the skill and experience to turn your idea into a practical and economical product.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

Making a one-ton load ...a one-man job on Westinghouse Switchgear

WINSMITH SPEED REDUCERS®

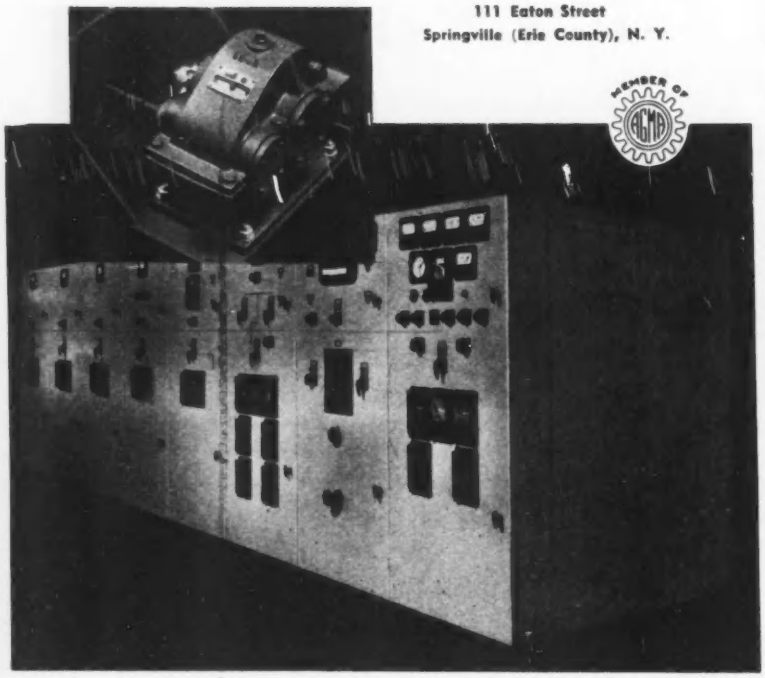
Even though it weighs a ton, when the oil circuit breaker on Westinghouse "Unitized" Heavy Duty Switchgear is removed periodically for inspection, it's only a one-man job. A power-elevating mechanism lowers the breaker onto a hand truck and lifts it back to operating position in about 3 minutes.

Heart of the elevating device is a motor-driven Winsmith Helical Gear Speed Reducer, with an input of ¾ hp at 1725 rpm and a reduction ratio of 9.5 to 1, which operates 4 shaft-connected screw-lifts via a drive chain. Like all components of 100% standardized Westinghouse Switchgear, the Winsmith reducer is itself a product of complete standardization.

Whether your power transmission requirements are intermittent like this switchgear, or continuous . . . heavy duty or light . . . Winsmith is the *only* name in speed reducers you need remember. Standardized worm, helical and patented differential gear units are available to serve your specific needs throughout the 1/100 to 85 hp range, in ratios from 1.1:1 to 50,000:1. *Request Catalog 148 for details.*

WINSMITH, INC.
111 Eaton Street
Springville (Erie County), N. Y.

MEMBER OF AGMA



technique for large objects, beyond the practical limits of powder-metal tooling and presses. "Spray metallurgy" is a form of powder metallurgy, except that plastic metal particles are shaped by force of impact rather than ordinary mechanical compaction. Most metals, except certain tungsten alloys, may be sprayed by the available methods.

Thin-walled bodies of rotational symmetry impossible or impractical to form by powder metallurgy, casting, forging, or machining from the solid can be produced by metal spraying, followed by sintering in a reducing atmosphere. Maximum density is imperative to achieve optimum mechanical properties. Porosity and oxide content of an as-sprayed body determine its usefulness. However densification and removal of oxides are much improved if a liquid metallic phase of sufficient quantity is formed during sintering. At present, it is difficult, if not impossible, to achieve bulk density with pure metals. Total removal of oxide by hydrogen reduction is hindered by the difficult removal of entrapped water vapor in the later sintering stages.

It is also possible to spray and sinter certain shapes of nonrotational symmetry, but shrinkage cracks occur readily, unless sufficient liquid phase is formed before appreciable densification takes place. In this respect, stresses developed during the shrinkage of deposits on flat surfaces will either peel or crack the deposit. They may even occur during spraying of thicker deposits on plane surfaces.

Spray Process

Drawn wire or cast rod of the metal or alloy to be sprayed is fed through the center of an oxyacetylene flame by a gear train driven by an air turbine. The metal, upon melting, is atomized by a compressed-air blast which surrounds the flame. The sprayed metal particles still are at their melting point when they reach the object being metallized. (This was determined in experiments performed as a preliminary to this project). Upon impact the particles readily collapse; assume the contour of the surface they strike, roughly resembling a random stack of miniature flapjacks that overlap each other in varying degrees. Controlled spraying "knits" the various stacks and result in the desired shape.

Mandrels are made of graphite tubes fitted over steel shafts and slightly roughened to cause the particles to stick. Graphite mandrels are seldom satisfactory for any but cylindrical shapes. It is very difficult to get

sprayed particles to stick on flat graphite surfaces.

For most cylindrical parts, graphite mandrels are provided with draft to permit pressing the part off the mandrel after forming. Prior to sintering the part is removed from the mandrel by pressing, or by machining out the mandrel if the internal configuration prevents the use of draft. A high-temperature ceramic cylinder is inserted into the part to prevent it from collapsing at the high sintering temperature. This ceramic cylinder must be a good fit, conforming closely to the sprayed part shape. Cylinders are readily removed after sintering.

National Carbon Co. AGX graphite sleeves were fitted to $\frac{3}{4}$ in. dia steel shafts to serve as the mandrels. This material has excellent machinability and a good, smooth finish is readily obtained. After the graphite sleeve has been machined to 1.125 in. dia, the assembly was rotated in a lathe and sprayed with a coating of metal, using a $\frac{1}{8}$ in. dia metal wire or rod and a Metco style spray gun. Acetylene was used in combination with oxygen and compressed air.

Many factors determine the proper distance for any given job. These things include: material, gun-size, air pressure, temperature, and feed rate. Ideal distance should be calculated to suit each new job.

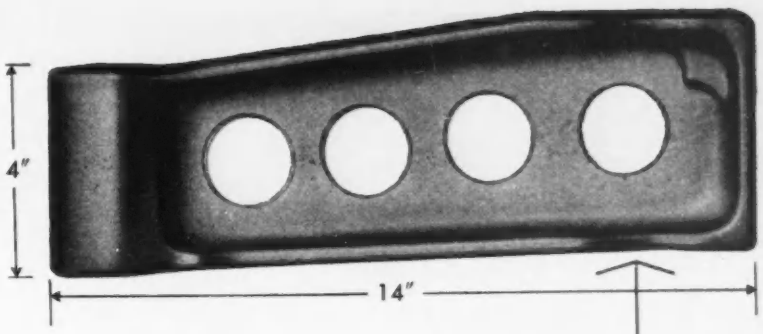
After spraying, the metal coating was dry ground to 1.155 in. with a high-speed toolpost grinder, to leave a 0.015 in. wall sleeve. The steel shaft

Table I—For nickel, bursting strength increases as the theoretical density; both are inversely proportional to amount of oxide

Oxygen percent	Bursting Strength (psi)	Density (percent) theo.
0.46	9,400	91.8
0.44	10,600	92.7
0.32	11,100	93.6

Table II—As-sprayed strength of Vitallium and Hastelloy C deposits was fairly good. These were sprayed from laboratory-made rod . . .

Metal	Bursting Strength (psi)
Vitallium	20,000
Hastelloy C	20,100
CM-469 (60% Cr, 25% Mo, 15% Fe)	9,200

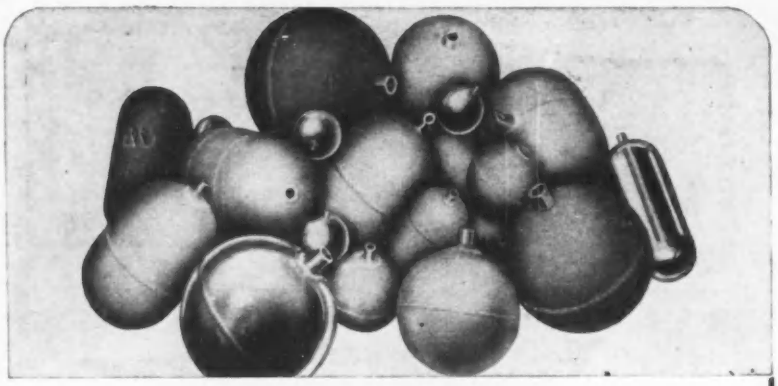


From Jet Bomber Parts
to Gas Range Burners
MUELLER BRASS CO.
Aluminum Forgings Save Weight, Save Finishing Time and Provide the Same Strength as Steel

If weight and strength are important factors in your product, then Mueller Brass Co. forged aluminum parts may be your best bet. Mueller aluminum forgings weigh only ⅓ as much as steel, yet they are approximately as strong. They make ideal parts for many applications and they are particularly desirable as parts for high speed rotating and oscillating machines because they reduce vibration and bearing loads, thus causing less wear on other parts. They possess good dimensional stability and retain their mechanical properties at high speeds and reasonable temperatures. The smooth, bright surfaces save machining time and eliminate costly finishing. Mueller Brass Co. can forge aluminum parts to your specifications in any practical size and shape from any of the standard or special alloys. Write us today for complete information.

MUELLER BRASS CO.
PORT HURON 17, MICHIGAN

91



Send for Nicholson

FLOAT BULLETIN 650

Complete Data on Welded Floats; Diagrams, Tables, Formulae for Calculating Buoyancies

The booklet is a standard reference for specifiers of welded floats. Nicholson furnishes any type for external or internal pressures; in stainless steel, Monel, chromium, cadmium or copper - p'ated steel. Sizes, 2" to 14" diam., press. to 4800 lbs.; standard or special connections. Quick delivery on many sizes and shapes. Nicholson floats are standard with hundreds of manufacturers.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

200 OREGON ST. WILKES-BARRE, PA.

Stock Sprockets with "custom" precision

Orders for Sewall Stock Sprockets carry the assurance of complete interchangeability and satisfactory performance. Wide range of sizes. *Send for the Sewall Catalog.*

Prompt quotations on your requirements of special gears and sprockets.

By the Makers of Sewall Gears

E. B. SEWALL MANUFACTURING CO.

707 Raymond Ave. • St. Paul 14, Minnesota

Table III — Strength of Vitallium and Hastelloy C is doubled with 1 hr sinter at 1,300-1,325 C; strength of CM-469 gains 50 percent : . .

Metal	Sintering Treatment	Bursting Strength (psi)	Density (percent) theo.
Vitallium....	1 hr @ 1,325 C	42,000	100
Hastelloy C.	1 hr @ 1,300 C	44,000	100
CM-469.....	1 hr @ 1,350 C	14,030	92.4

Table IV—Molybdenum deposit strength was increased when a nickel liquid phase increased density. However, 6.0 percent nickel gave 100 percent density but set up brittle intergranular delta phase; lowered strength . . .

Composition	Sintering Treatment (1375 C)	Bursting Strength (psi)	Density (percent) theo.
0.25% Ni...	1 hr	13,250	93.8
0.78% Ni...	1 hr	21,000	95.1
6.0% Ni....	1 hr	8,000	100.0

Table V—With 1 hr hydrogen sinter at 1,350 C, strength of nickel tripled. Although density was increased only 4 percent, oxide was reduced . . .

Sintering Treatment (1350 C)	Bursting Strength (psi)	Density (percent) theo.
15 min.....	23,800	96.1
30 min.....	24,150	97.1
60 min.....	30,000	97.6
480 min.....	34,000	98.0

was pressed out and a cylinder 2 in. long was removed from the center portion of the spray coat. The graphite was removed from the 2 in. section of sprayed metal and the internal surface paper polished. This piece, as-sprayed, was then hydrostatically tested for bursting strength.

Many different alloys were sprayed successfully. Among these metals were Vitallium, which was sprayed from hot-swaged rod, and Hastelloy C and CM-469, which were sprayed from as-cast rod prepared in the laboratory. Melts of the last two alloys were made in a 5 lb high-frequency induction furnace. Molten metal was drawn from the crucible by vacuum into Vycor glass tubes, producing rods approximately

Cramer TIMING DEVICES

NEW TIME TOTALIZER
MODEL ET

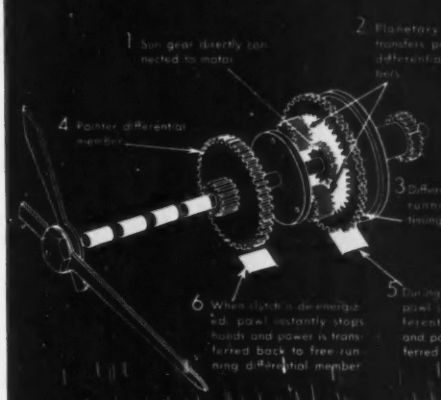
better than
0.02 of 1%
accuracy

Designed to the most exacting specifications for such applications as timing operations in industrial laboratories or for measurement processes in the chemical and metals industries. Incorporates new principle of differential clutching that prevents slippage and overrun and insures unusually high accuracy and dependable performance.

FEATURES

- *High Accuracy*... Better than 0.02 of 1% of full scale reading.
- *Positive Clutching*... Differential gear clutch provides positive action. No friction element to slip or wear. Accuracy further improved by clutching at a high-speed part of the gear train.
- *Extra Strength Motor*... High torque motor insures adequate reserve for adverse operating conditions.
- *Easy-to-Read Dial*... Large sweep hand permits extremely precise readings.
- *Compact Size*... Takes up minimum space on crowded panels... ideal for portable or airborne equipment.
- *Military Specifications*... Models available to meet exacting specifications as to shock, vibration, temperature, etc.

POSITIVE ACTION CLUTCH
WITH DIFFERENTIAL GEAR
PREVENTS SLIPPING OR OVERRUN


1 Sun gear directly connected to motor
2 Planetary system transfers power to differential members
3 Differential member free running except during timing cycle
4 Pointer differential member
5 During timing cycle pawl stops free differential member and power is transferred to pointer
6 When clutch is de-energized, pawl instantly stops clutch and power is transferred back to free-running differential member

In this unique clutch mechanism, the motor is permanently connected to the sun gear of a differential gear system. A solenoid pawl moves between the two differential members so that only one is free to rotate at one time. Starts and stops are thus effected by positive engagement of pawl with gear. There can be none of the slippage or overrun associated with friction clutches; nor can characteristics change with age.

the R. W. CRAMER CO., INC.
Box No. 7, Centerbrook, Conn.

Please send complete information about the ET Time Totalizer. (Please check) ☐
Send copy of General Bulletin on Synchronous Timing Motors and Electric Timers. ☐

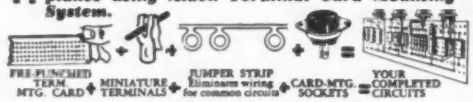
NAME: _____
Address: _____

6CR53R

Now you can readily design your Electronic Equipment for unitized PLUG-IN UNIT CONSTRUCTION

New free Alden Handbook simplifies plug-in unit design. Presents complete line of basic components of tremendous flexibility for adapting your equipment to plug-in construction.

1. Unitize your circuitry in compact vertical planes using Alden Terminal Card Mounting System.



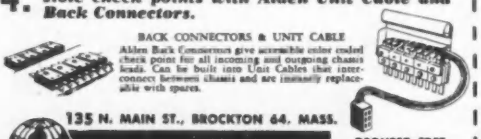
You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets staked to accommodate any circuitry — making complete units ready for housing. Components snap into unique Alden Terminals, are held ready for soldering.

2. Make your circuits neat accessible plug-in units by mounting in Alden "20" Package or Basic Chassis.

Alden components provide standard plug-in or slide-in housings — with spares, your circuits become units replaceable in 30 seconds.

3. Monitor your plug-in units with ALDEN SENSING ELEMENTS that spot trouble instantly.

4. Get fool-proof unit interconnections and accessible check points with Alden Unit Cable and Back Connectors.



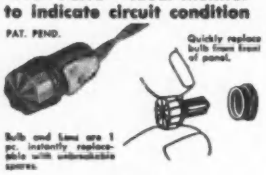
Alden Back Connectors give accessible color coded check points for all incoming and outgoing chassis leads. Can be built into Unit Cables that interconnect between chassis and are instantly replaceable with spares.

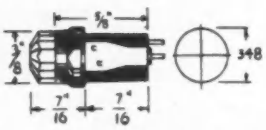
135 N. MAIN ST., BROCKTON 64, MASS.

ALDEN PRODUCTS CO.

REQUEST FREE "ALDEN HANDBOOK"

Here's the story on "PAN-I-LITE"—ideal monitor to indicate circuit condition





The panel lights you've used — were bulbs easy to replace? Were spares durable and always on hand? Did the user have to call a service man to replace a light? Was it hard to find panel room to build in the lights you wanted? Did your equipment look like a Christmas tree, with a confusing glare of lights?

At last — here's a Pan-i-Lite so well thought out you need never use any other. You know a dead light means danger. Pan-i-Lite's 1-piece bulb-and-lens is so easily replaceable, it's never neglected. Spares are unbreakable, easily kept in kit, vest pocket, or taped right in a recess of equipment. Instantly replaceable. Glow like a red hot poker, yet never with glare that gives false signal. Tiny Pan-i-Lites punch into a .348" drill hole, take about ½" behind panel, mount on centers .44" apart, allowing 900 Lites per sq. ft. of panel.

Now you can use indicator lights wherever needed. Avoid hazard of dead light, because bulb replacement instant, easy, by anyone. For ALL indicator needs, standardize on Pan-i-Lite, the light that really makes sense!

Send for Samples of 3 Pan-i-Lites with 4 brilliant color replacement bulbs. Laboratory Work Kit #33, price $6.00. OR SEND $1.00 FOR DEMONSTRATOR

• SINCE 1926 • in the application, design and mfg. of pumps — separators — hydraulic accessories.

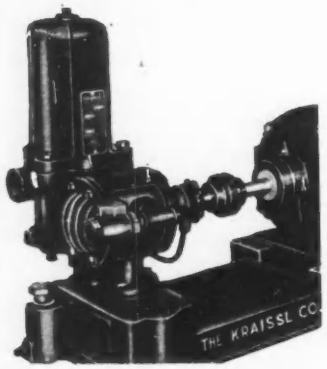
KRAISSL ROTARY AIR PUMPS

FOR VACUUM AND PRESSURE • AIR COOLED

Designed for high efficiency—for the *packaging and printing machine fields.* Rigorous on-job tests prove Kraissl pumps are the economy answer to your vacuum and air-under-pressure problems. Exclusive Kraissl design assures you maximum performance—and lower costs. Compact and lightweight—with exceptionally large capacities for size; force-feed lubrication system gives continuous heavy-duty service.

FREE!
Bulletin A-1289 gives you complete data on Kraissl Rotary Air Pumps. Write for it today.

If you have any special problems—if you need any detailed information—please write us fully. You will receive a prompt and detailed reply.



Features of Kraissl Class 25 Air Pumps

- Run at direct motor speeds—but not limited to motor operations
- Integrated oil-air filter available
- Forced-feed lubrication system
- Compact and lightweight
- High capacities

KRAISSL CO

289 Williams Ave., Hackensack, N. J.

12 in. long. After solidification the glass was removed and the short lengths welded together, using atomic hydrogen into lengths of 5 ft or more. Properties of some sprayed and sintered metals are listed in the included tables.

High Temperature Non-Critical Materials

Abstracted from "Non-Critical Materials for High Temperature Work." *Mechanical World,* September, 1952.

WITH THE DEMAND FOR METALS to withstand operation temperatures well in excess of 1,000 F a whole new range of alloy steels have been produced, some of them containing so great a proportion of alloying metals that the amount of iron remaining is less than one-half.

These high temperature steels are generally called special service alloys or super alloys—alloys rather than steels because of the high content of metals other than iron itself. Unfortunately the alloying metals commonly employed—cobalt, columbium, nickel and tungsten, are all "critical" materials.

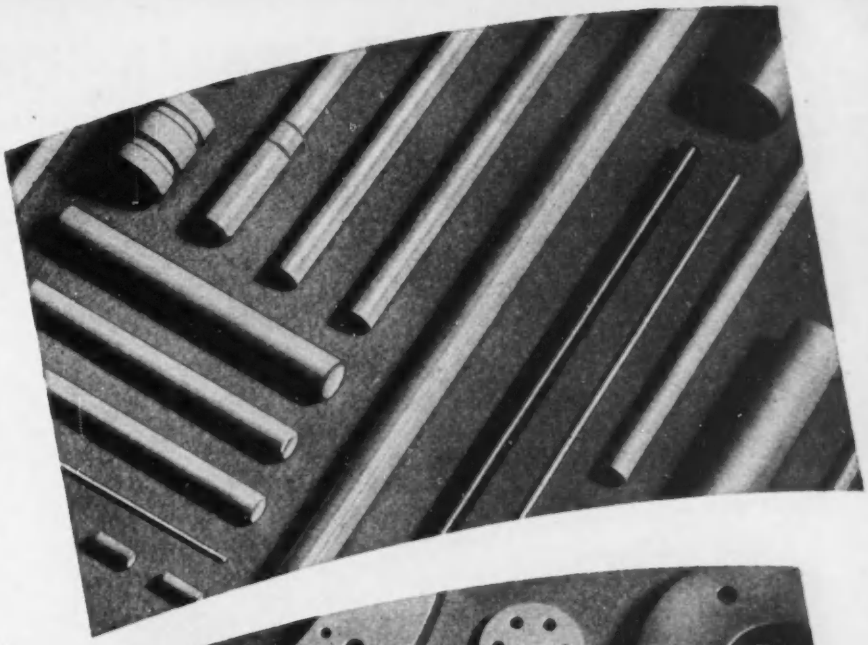
The supply position of high alloy steels threatened to reach such a critical state that something had to be done about it. Other alloying metals were tried, but those which give the best results were just as difficult to come by as the materials they were intended to replace. Then came the idea of air cooling hot jet engine parts and so reducing the operating temperatures to a figure compatible with the use of lower alloys. This trend in design is now most marked, both in England and America and promises to go a long way towards easing, if not solving, the material supply position.

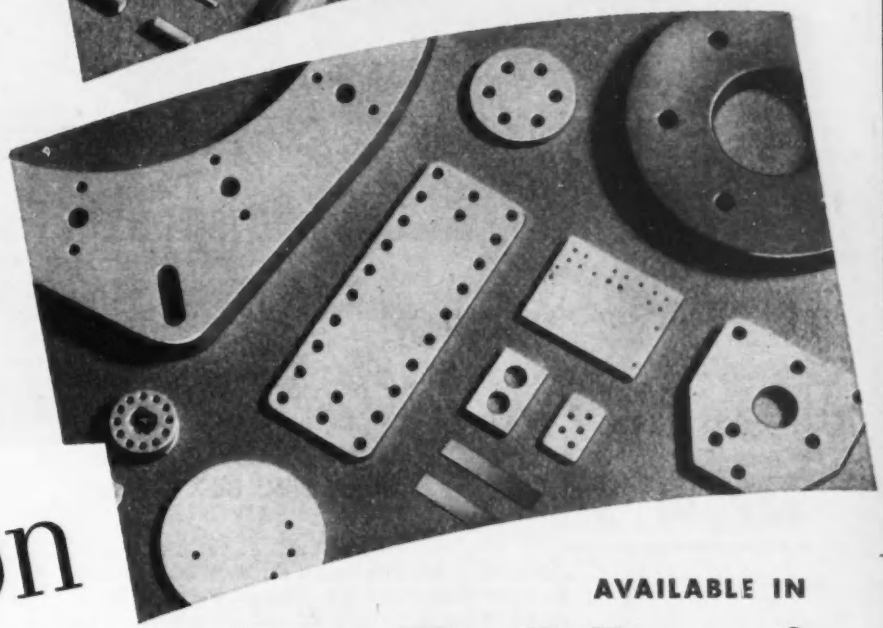
In other applications quite a different line has been taken, with even greater success. Here metals have been replaced by non-metallic refractory materials—not ordinary ceramic refractories but bonded silicon carbide of high strength and amazing heat resistant properties. Whereas even the best of heat resisting steels begin to soften at around 1,500 F, bonded silicon carbide retains its strength properties at temperatures in excess of 3,000 F or temperatures where metals would have melted.

Probably one of the most outstanding examples of the use of bonded silicon carbide to replace metals is in the liner and throat of uncooled rocket motors. Here, it is estimated, working temperatures may exceed 5,000 F for short periods. During actual operation, a

- Outside diameter of tubes and rods as small as .062" diameter centerless ground to tolerance of ±.0001".
- Rods free of camber for precision shafts.
- Rods and tubes centerless polished to 5 micro inch RMS finish 5/.
- Cylindrical parts ground both inside and outside to diameter tolerance of ±.0005" with concentricity of .001" TIR. Sizes up to 8½" O.D. by 24" long are available.
- Holes as small as .187" diameter can be economically lapped to tolerance of ±.001".
- Plates and discs up to 50 square inches can be precision ground. Flat parts up to 4 square inch area are ground flat and parallel simultaneously on two sides; flat within .0002", parallel within .0005", and thickness tolerance .001" is practical.
- Parts lapped flat within a few light bands. Special parts have been lapped to .008" thickness.

As a rule of thumb: On critical dimensions which lend themselves to grinding, AlSiMag ceramics can be furnished with the accuracy of comparable precision metal parts. AlSiMag ceramics are more wear resistant than steel and, in many designs, can be manufactured to close tolerances at lower cost.





Precision TOLERANCES

AVAILABLE IN

ALSIMAG®

CUSTOM MADE TECHNICAL CERAMICS

Each year we have added more equipment and gained more skill and experience in grinding AlSiMag ceramics. We like difficult and complicated problems. If you have a tough one, send it to us. We'll tackle it.

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • PHILADELPHIA, 1649 North Broad St., Stevenson 4-2022 • CLEVELAND, 5012 Euclid Ave., Express 1-4685 • SOUTHWEST: John A. Green Co., 6815 Oriole Drive, Dallas 9, Dixon 9918 • NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4498 • LOS ANGELES, 5603 N. Huntington Drive, Capitol 1-9114 • CHICAGO, 228 N. LaSalle St., Central 6-1721 • ST. LOUIS, 1123 Washington Ave., Garfield 4939

Here's how 13 Twin City Castings prove LUCKY in this SCOTCH BRAND Tape dispenser

13 TWIN CITY CASTINGS USED IN TYPE "M" BOX SEALER

Here was a job that called for *more* than accurate dies and close-tolerance castings. It called for *co-operation* between designer and die caster . . . the kind of cooperation so important to creative manufacture.

Result: an extremely successful manually operated box sealer for use with Scotch brand cellophane tape. The unit is built by Specialty Manufacturing Company for Minnesota Mining and Manufacturing Co., manufacturers of Scotch tape. The dispenser contains 13 zinc die castings from complex main frame to small trip-pin arm . . . all *Twin City* die castings and *Twin City*-built dies.

If you have a particular die casting job, large or small, that calls for "cooperation" with your die caster . . . contact Twin City. Hundreds of manufacturers have found that it pays.

TWIN CITY DIE CASTINGS CO.
3350 TALMAGE AVENUE S. E. · MINNEAPOLIS 14, MINN.

rocket motor will burn four tons of fuel in a matter of one minute. But very few metals will stand up to such heat even for that short time. Metallic liners and throats have, in fact, needed replacing after every single run. The same components made of bonded silicon carbide have a considerably enhanced life. The non-metallic refractory used in this case is actually cheaper and certainly avoids the use of any material in short supply.

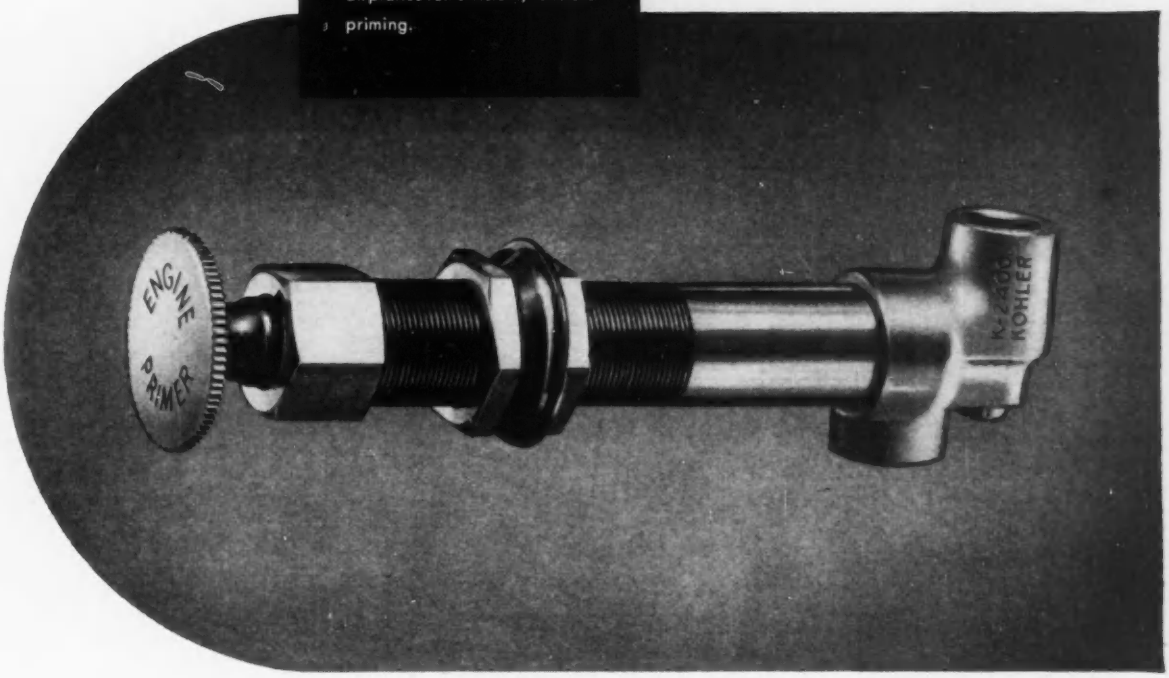
In less spectacular fields, too, silicon carbide refractory material is replacing special service alloys where heat resistance is a primary factor. Bonded silicon carbide is not just a substitute material. It was first tried as that, but proved to have superior properties in so many cases that it is now more often than not a "first choice" material for such jobs. Overall savings in nickel and chromium, main constituents of the general purpose heat resisting alloys, should not be inconsiderable once the full possibilities of bonded silicon carbide are realized and exploited.

As far as the metals situation is concerned, however, further relief in critical materials is foreshadowed by the increasing application of low alloy steels to do jobs formerly considered only feasible with high alloys.

Broadly speaking, engineers have kept off using low alloy steels for high temperature work since the available strength figures at such temperatures showed correspondingly low results. These data, however, invariably referred to annealed material. By varying the heat treatment a considerable increase of high temperature strength is possible. Higher solution temperatures (around 2,000 F) and high normalizing temperatures have produced low alloy steels (e.g. 0.3 carbon; 0.6 manganese; 0.7 silicon; 1.25 chromium; 0.5 molybdenum; 0.25 vanadium) with a rupture strength in excess of 60,000 psi at 1,000 F with a fracture time of 1,000 hours.

There is still a lot to be found out as regards the best method of heat treatment of low alloy steels for best "hot" strength. Very high normalizing temperatures tend to produce a material which is brittle at around 1,100 F showing elongations to fracture of 1.0 percent or less. Optimum normalizing temperature will vary with the exact composition of the material, but a temperature around 1,800 F, followed by tempering to between 300 and 350 Brinell is generally capable of giving an elongation to fracture in the region of 5.0 percent, which is adequate for most purposes for which such steels are intended. Some typical figures are summarized in Table I,

Kohler Engine Primer—specified by manufacturers of Diesel engines and personal airplanes for efficient, reliable priming.



KOHLER PRECISION CONTROLS

- **Aircraft**
- **Industrial**
- **Automotive**

Kohler Co. is a leading supplier of precision controls, including pneumatic, hydraulic, fuel valves and fittings, to manufacturers of jet engines, military, commercial and private aircraft, agricultural and industrial test equipment and Diesel engines.

Facilities for forging, die casting, machining, anodizing, are maintained all in one plant—with an experienced organization skilled in precision workmanship.

Our engineers develop, for volume production, controls to specification. Write for illustrated booklet.

Kohler Co., Kohler, Wisconsin. Established 1873.

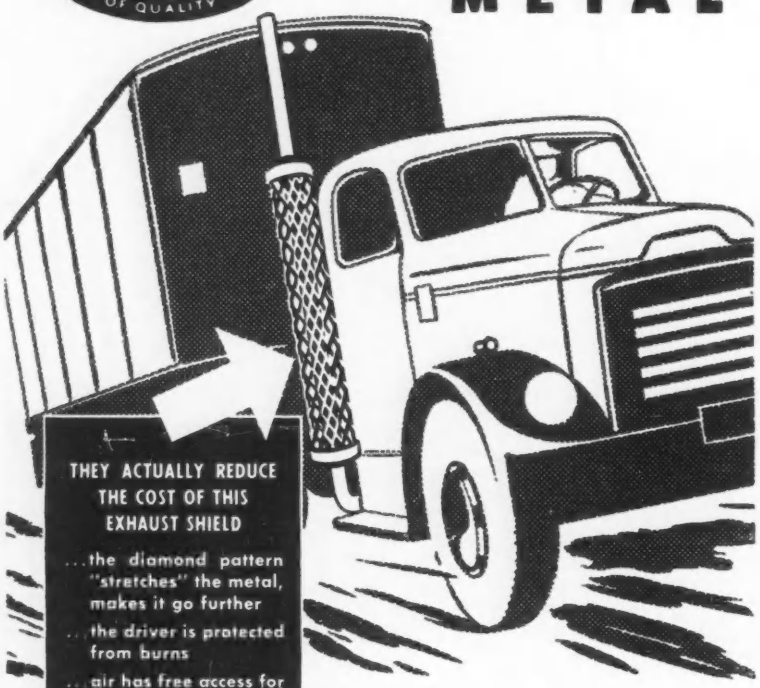
KOHLER OF KOHLER

PLUMBING FIXTURES · HEATING EQUIPMENT · ELECTRIC PLANTS · AIR-COOLED ENGINES · PRECISION CONTROLS

Cheapest "Diamonds" You Can Buy

METAL MARK Penmetal 1869 OF QUALITY

EXPANDED METAL



THEY ACTUALLY REDUCE THE COST OF THIS EXHAUST SHIELD

...the diamond pattern "stretches" the metal, makes it go further

...the driver is protected from burns

...air has free access for cooling

and you have an attractive product!

Manufactured of ½" 18 gauge PENMETAL by Toledo Pressed Steel Company for GMC Truck & Coach Company

EXPANDED METAL MESH

OPEN TO LIGHT, HEAT AND AIR. PENMETAL expanded metal is the material of economy—for protecting, for screening, for lightweight yet strong construction.

MAKES A LITTLE METAL GO A LONG WAY. PENMETAL expanded metal is sheet metal which has been slit, then stretched to as much as 10 times original area.

CORROSION-RESISTANT METALS AVAILABLE, as well as carbon steel. Large or small mesh, light or heavy gauge. Each sheet is a unit without rivets or welds.

UP TO 80% LIGHTER than solid sheet of same dimensions. Diamond truss pattern adds rigidity and strength.

METAL MARK Penmetal 1869 OF QUALITY

For more information, write for Free Bulletin EM40

PENN METAL COMPANY, INC.

GENERAL SALES OFFICES • 205 East 42nd Street, New York 17, N. Y.

BOSTON, PHILADELPHIA, WASHINGTON, PARKERSBURG, W. VA., DETROIT, CHICAGO, DALLAS, LOS ANGELES, SAN FRANCISCO, SEATTLE

TABLE I—Low Alloy Steels

	C	Si	Cr	Mo	V	
1	0.10	0.75	1.30	0.50	0.25	0.67 Ti 0.04 B
2	0.09	0.60	1.29	0.54	0 41	
3	0.22	0.60	1.34	0.54	0.80	
4	0.22	0.62	3.00	0.63	0.79	0.55 W
5	0.28	0.71	1.52	0.51	0.77	0.48 W
6	0.30	0.68	1.36	1.04	0.31	0.82 Ti
7	0.32	0.86	1.43	0.55	0.76	0.43 W 0.0015 B
8	0.33	0.68	1.35	1.04	0.27	

	Normalized at F	Tempered at F	Rupture characteristics at 1,100 F: Strength (psi)	Rupture characteristics at 1,100 F: Elongation (percent) to fracture
1	1,950	1,200	20,000	10
	2,100	1,100	27,000	10
	1,750	1,200	22,000	10
2	1,950	1,200	26,000	5
	2,100	1,200	25,000	6
	1,750	1,200	32,000	6
3	1,800	1,200	34,500	5
	2,100	1,200	24,500	1
4	1,850	1,200	31,000	10
5	1,850	1,275	32,000	1
6	1,950	1,250	34,500	16
	2,050	1,250	32,500	2
7	1,850	1,250	38,000	1
	2,000	1,275	38,000	1
8	1,850	1,275	27,000	1
	2,000	1,275	23,000	0

based on data obtained by the Steel and Tube Div. of the Timken Roller Bearing Co. of Canton, Ohio.

Most of the British low alloy steels developed for high temperature application employ a proportion of columbium (under 1.0 percent) and higher than normal solution temperatures in either the normalizing or quenching treatment. Rupture strength values for 1,000 hr at 1,100 F are then of the order of 40,000 to 45,000 psi. On this basis it seems feasible to adopt similar low alloy steels for high stress between 1,000 and 1,100 F, provided the life of that particular component need only be relatively short. These alloys certainly meet the other main requirement of a "substitute" material in that only the minimum of critical elements is employed. Total alloy content is usually under 2.0 percent. Maximum high temperature strength is obtained through simple heat treatment.

OUR READERS SAY

Taylor's Solution Same as Newton's

To the Editor:

On page 217 in the December 1952 issue of *Product Engineering* under the heading of "Using Taylor's Series to Solve Spiral Gear Problems" by Harold M. Durham, the solution of a trigonometric equation is shown. This solution is the same as Newton's method although the derivation is sometimes quite different. It seems that engineers in general are not too well acquainted with the generalized method. The method applies to cubic and higher degree equations and also to trigonometric, exponential and logarithmic equations. Newton's method was explained in *Product Engineering* for August 1932 under the title "Solving Higher Degree Equations" by Norman W. Wickstrand.

Newton's method can also be found in several textbooks on applied mathematics, for example:

Higher Mathematics for Engineers and Physicists by I. S. & E. S. Sokolnikoff page 97 and Methods of Advanced Calculus by Philip Franklin page 26.—NORMAN M. WICKSTRAND, *Bristol, Conn.*

Improvement on Taylor Series Solution

To the Editor:

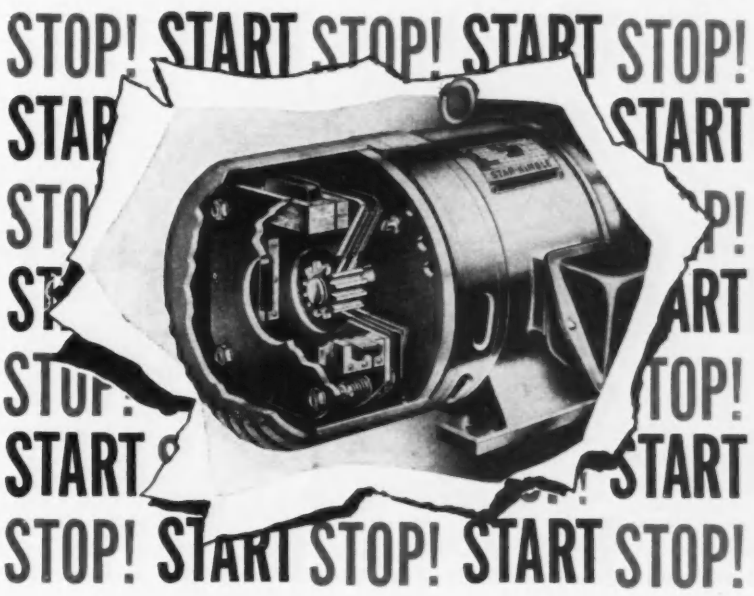
On page 217 of the December issue of *Product Engineering* is a calculation of a pair of Spiral Gears by Mr. Harold M. Durham. Mr. Durham has used the Taylor Series for correcting an approximate solution.

However, I believe that this can be done much simpler with a different graphical solution. This solution is credited to Mr. J. K. Olsen, and was originally published in *Product Engineering*.

Two circles of a diameter equal to equivalent spur gears are drawn at the given center distance apart. Then, on a separate piece of tracing paper, two lines are drawn intersecting at the shaft angle—in this case, 90 degrees. This paper is then superimposed on the diagram of the gears in such a way that each line is tangent to one of the circles, and their intersection lies on

Positive, split-second stopping

SMOOTH, NO-DRAG STARTING
FAST, NON-PLUGGING REVERSING



You get them all when you specify Star-Kimble Brakemotors

NOTE THE EXTRA-LARGE BRAKELINING AREA—discs machined on both sides to give full, positive contact—that brings a Star-Kimble Brakemotor *and its connected load* to the same sure fraction-of-a-second stop through *millions of operations.*

NOTE THE SMALL AIR GAP between electromagnets and brake armature disc. It assures quick brake release—allows the load to start freely when the motor is energized.

COMPARE THE REVERSING CYCLE of a Star-Kimble Brakemotor and a motor reversed by conventional plugging. Typical figures on maximum starts per minute for a 5 hp motor: with plug stops, *three;* with the Star-Kimble way, *ten!*

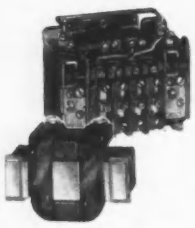
REMEMBER a Star-Kimble Brakemotor is a compact, integral unit, with a short sturdy shaft that's common to motor and brake. Saves space—saves bearing and brakelining wear. One manufacturer—one responsibility.

For information on design and service features, write for Bulletin B-501-A

STAR-KIMBLE
MOTOR DIVISION OF
MIEHLE PRINTING PRESS AND MFG. CO.
211 Bloomfield Avenue Bloomfield, New Jersey

THERE IS AN R-B-M CONTROL To Fit Your Needs

A.C. MAGNETIC STARTERS
with Plasti-Clad Magnet Coil
•
Write for Bulletin 605



Full accessibility in a small package.

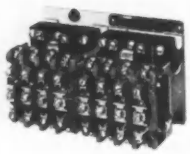
Contacts, coil and thermal element replacement with use of screwdriver only. Magnet coil — in molded phenolic case with riveted terminals—is completely embedded in a rock-hard resinous material, thus protecting against oil, dirt, moisture and normal mechanical damage.

HERMETICALLY SEALED RELAYS
•
Write for Bulletin ASR
•

50% smaller — lighter.

R-B-M 22204-0 meets AN 3304-1 specifications. R-B-M engineers have developed the 22300-0 currently used in government electronic, airborne and ground equipment —as the electrical and mechanical equivalent of the AN 3304-1, yet 50% smaller in size with ½ the weight.

INDUSTRIAL CONTACTORS
with Plasti-Clad Magnet Coil
•
Write for Bulletin 600
•



2-8 poles Non-Reversing.
2-5 poles Reversing.
25 Amp — 600 AC Max.

Contacts can be replaced without removing wiring. To change coil, remove magnet frame and coil assembly only. 10 and 15 amp. poles can be changed from normally open to normally closed by using screwdriver only.

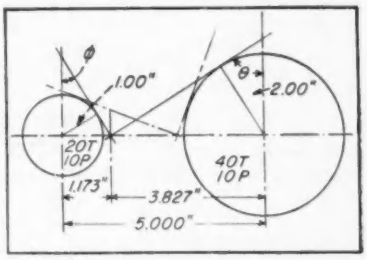
GENERAL PURPOSE RELAYS
•
Write for Bulletin 570
•

Low cost. Small size. Dependable performance. Available in many contact arrangements.

Whatever your needs for inexpensive, dependable relays for commercial applications—investigate R-B-M General Purpose Relays.

Other R-B-M products include: motor overload protectors, motor starting relays and low voltage DC electrical devices.
Consult R-B-M On Your Control Problems—Write Department C-2

RBM
R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana
MANUAL AND MAGNETIC ELECTRIC CONTROLS
— FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE



the center line through the two gear centers. The distance from this intersection to the respective centers is the pitch radius of the gears, and the angle of the diagonal line with the vertical center line in each case is the helix angle of the teeth.

The solution is given in the illustration, and solves the same problem as Mr. Durham.

Scaling the diagram carefully, the pitch radius of the driver, (d), is found to be 1.173 in. and that of the driven, (D), 3.827 inches.

Helix Angles,— driver.

Cos. $\theta \frac{1}{1.173}$ = 31° 30′ 49″

driven.

Cos. $\theta \frac{2}{3.827}$ = 58° 29′ 35″

Adding,— 31° 30′ 49″
58° 29′ 35″
89° 59′ 84″
89° 59′ 84″
60
24″ error.

(This seems quite an error, but actually amounts to about 25 feet in 40 miles. It is a question whether the nearest practical lead that could be cut wouldn't introduce as large an error).

This error will be subtracted from the smaller angle, as having the least effect on the diameter.

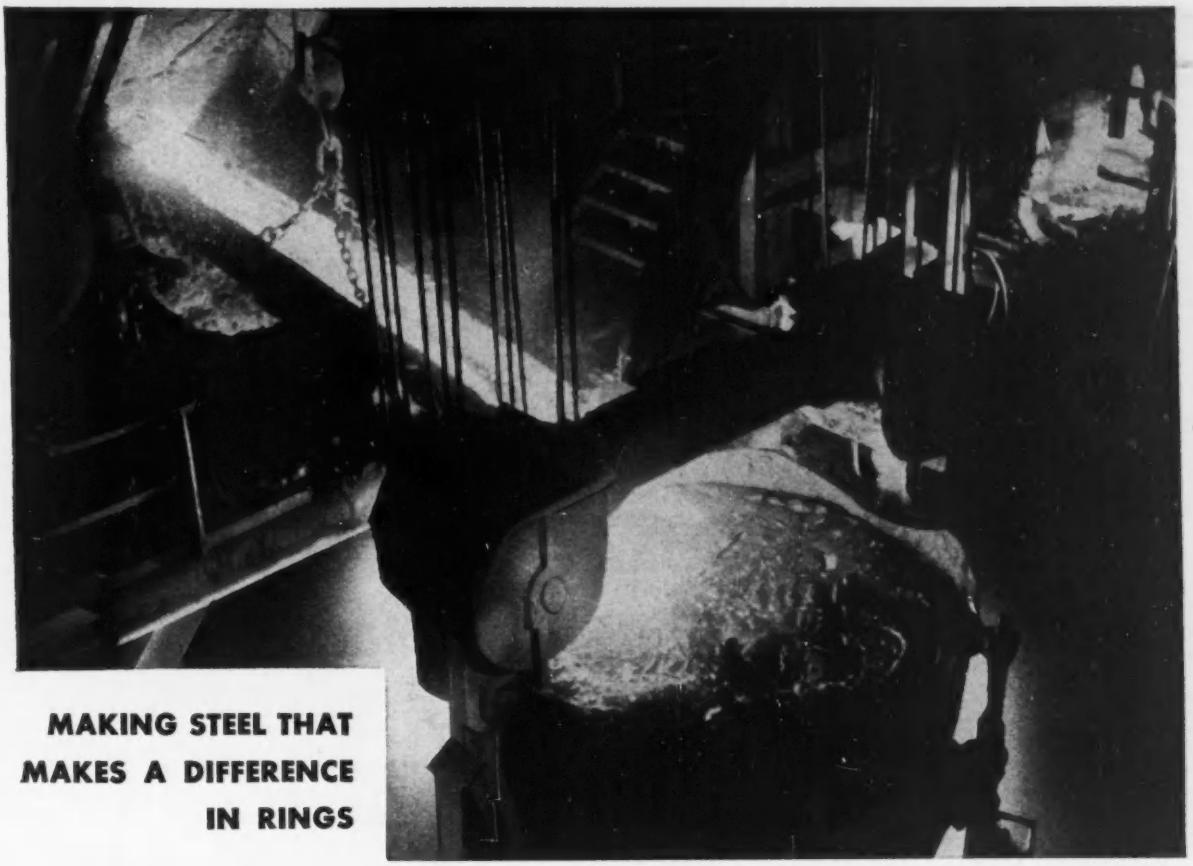
This gives us,—

driver
θ = 31° 30′ 25″
Radius (d) = $\frac{1}{2}\overline{\text{Cos } \theta}$ = 1.17288
Diam. (d) 2.24576

driven
θ = 58° 29′ 35″
Radius (D) = $\frac{2}{2}\overline{\text{Cos } \theta}$ = 3.82704
Diam. (D) 7.65408

Adding 1.17288
3.82704
4.99992 Centers
5.00000
0.00008 Error. Negligible, of course.

There is a second solution indicated by the broken lines. This was not



MAKING STEEL THAT MAKES A DIFFERENCE IN RINGS

By making its own steel in five open hearth furnaces, the Standard Steel Works Division constantly controls the steel in its forged rings and flanges. A combined yearly capacity of 200,000 tons of carbon and alloy steel are made by the acid open hearth method. This process makes possible more definite control of chemical reactions, assuring steel high in quality and tensile properties.

Thus one big reason why you should always call Standard for rings and flanges is the fact that Standard is able to produce and control the analysis and physical properties of the steel going into its products.

ONE OF SIX REASONS why you should always call Standard Steel for rings and flanges

1. **Quality Steel**—through production of own steel by acid process.
2. **Uniformity**—assured by precise control of forging and rolling operations.
3. **Testing**—modern laboratory control with radiographic tests, tensile tests, hardness tests, ultrasonic probing of internal structure, etc.
4. **Capacity**—unsurpassed ability to produce weldless rings all the way up to 144" O.D.
5. **Experience**—produced by skilled workmen with 20 to 40 years experience.
6. **Fast Service**—a vital factor in the continuing growth of Standard Steel for over 150 years.

Standard Steel Works Division

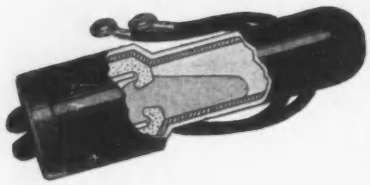
BURNHAM, PENNSYLVANIA

BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

Millions of Contacts without Faltering

PROVED
ON
rough, tough jobs



Durakool pressurized all-steel **mercury tilt switches** have more than made good on what may have seemed like extravagant claims a few years ago. The list of Durakool successes grows each year. Seven sizes, 1 to 65 amperes. 3 to 4 weeks delivery. Your production schedule is met.

WITHSTANDS
HIGH
TEMPERATURES

See telephone directory for local distributor or write
DURAKOOL, INC., Elkhart, Indiana

Durakool
ALL-STEEL MERCURY SWITCHES

chosen because of the excessive diameter of the driver.

This particular graphic solution is so simple, and easily constructed and is not restricted to shaft angle, that it should find wide application.

—H. B. SCHELL
Brooklyn, N. Y.

Information on Product Colors

To the Editor:

We are desirous of obtaining a copy of "How to Plan Product Colors" by Howard Ketcham, and copies of other reports on articles covering product improvement through better surface appearance. —L. R. BOND, *Kempthorne Proprietory Ltd., Oakleigh, Australia.*

Ed—We are mailing to you a reprint of the above article, plus a list of articles that we have on file on surface appearance.

Wants Book on Sheet Metal Work

To the Editor:

Product Engineering always was a good buy. With your Annual Handbook of Product Design for 1953 it is 100 percent better.

Incidentally, I am trying to locate a good book on sheet metal work-shop practice, fabrication, etc., for a training course. Can you recommend any?

—H. E. PILKINGTON

Ed—A good book for your purpose is "Sheet Metal Fabricating" by George Sachs of Horizons, Inc., Cleveland, Ohio. It is published by the Reinhold Publishing Co. in New York City. The price is $11.00.

Questions on Engineering Department Operation

To the Editor:

Of particular interest to me in your Annual Handbook of Product Design for 1953 is the article on page A16 entitled "Improving Engineering Department Operations," written by Mr. States Mead of Cresap, McCormick & Paget.

I have some questions about which I might want to write to Mr. Mead. The firm of Cresap, McCormick & Paget is not familiar to me. I would appreciate it if you would tell me something about them and about Mr.

Specify these GAST rotary-vane VACUUM PUMPS to solve your original equipment problem—

Light-duty Model 0440, 1/3 H.P., 3.8 C.F.M., 15" to 26" vac. Direct or V-belt drive.

Heavy-duty Model 1065, 1/4 to 1 1/2 H.P., 3.8 to 21 C.F.M., 26"-28" vac. Direct or V-belt.

V-belt Model 3040, 3/4 to 1 1/4 H.P., 19 to 24 C.F.M., moderate vac., V-belt drive only.

Integral Motor-Pump Model 0210, 1/4 H.P., 1.3 C.F.M., to 27" vac.

CHOOSE FROM A WIDE RANGE OF SIZES, TYPES

Gain lower maintenance and higher performance for your own products. Select the pump that fits your application from any of these types — in numerous sizes and combinations. Choose integral-motor, V-belt or direct drives, with or without bases or accessories, such as lubricators, mufflers, fans, filters.

Get the complete story . . . see how Gast Dry Vacuum Pumps excel for vacuum feeding, holding, testing, filtering. *Write for Catalog and Application Ideas Booklet!*

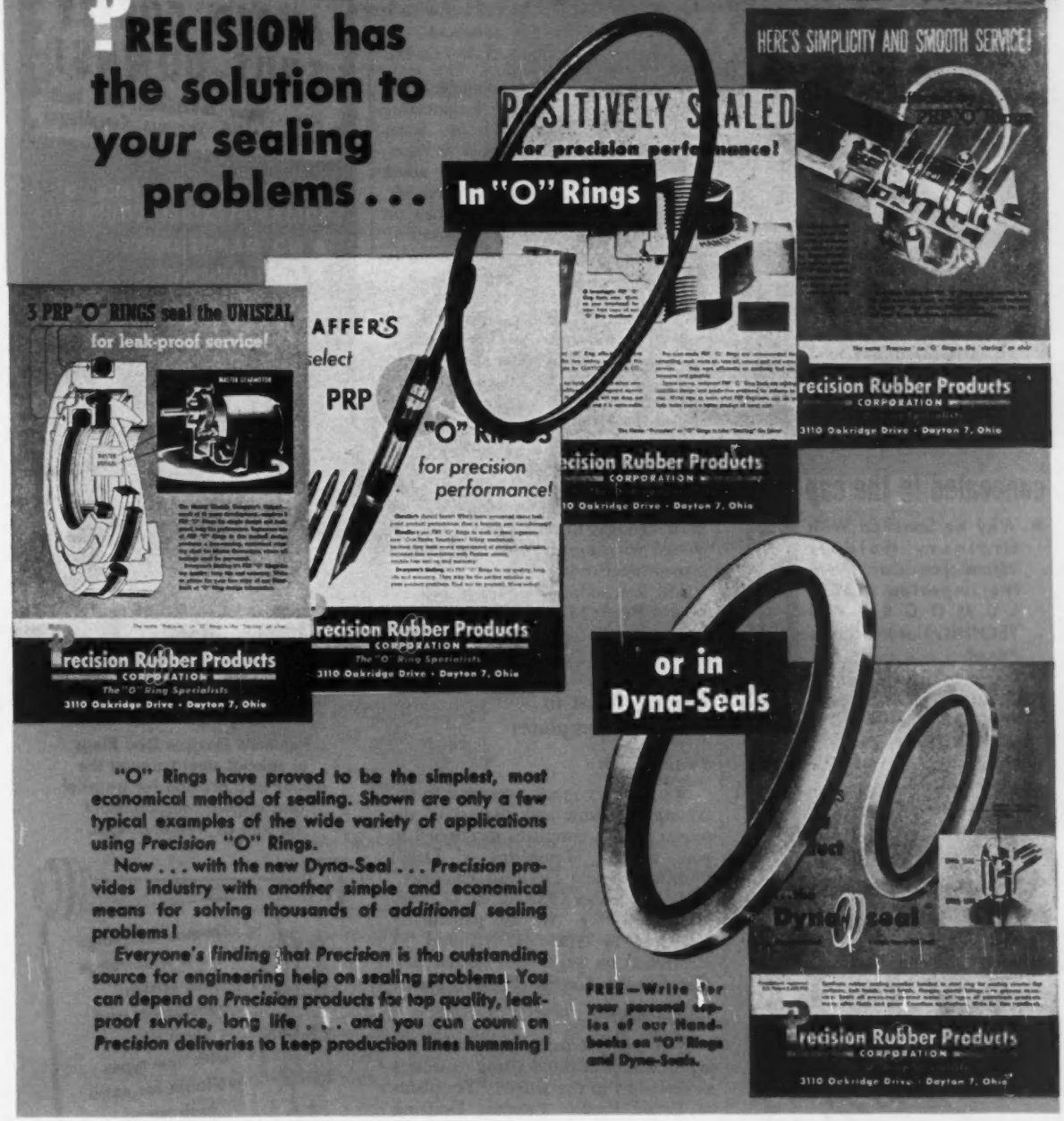
Original Equipment Manufacturers for Over 25 Years

GAST ROTARY
AIR MOTORS · COMPRESSORS · VACUUM PUMPS
(TO THREE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 189 Hinkley St., Benton Harbor, Mich.

PRECISION has the solution to your sealing problems . . .

In "O" Rings

or in Dyna-Seals


HERE'S SIMPLICITY AND SMOOTH SERVICE!
3 PRP "O" RINGS seal the UNISEAL
for leak-proof service!
for precision performance!
Precision Rubber Products
CORPORATION
The "O" Ring Specialists
3110 Oakridge Drive • Dayton 7, Ohio

"O" Rings have proved to be the simplest, most economical method of sealing. Shown are only a few typical examples of the wide variety of applications using *Precision* "O" Rings.

Now . . . with the new Dyna-Seal . . . *Precision* provides industry with *another* simple and economical means for solving thousands of *additional* sealing problems!

Everyone's finding that Precision is the outstanding source for engineering help on sealing problems. You can depend on *Precision* products for top quality, leak-proof service, long life . . . and you can count on *Precision* deliveries to keep production lines humming!

FREE—Write for your personal copies of our Handbooks on "O" Rings and Dyna-Seals.

Precision Rubber Products
CORPORATION
"O" Ring and Dyna-seal Specialists

Dept. 3, Oakridge Drive, Dayton 7, O. • Canadian Plant at: St. Therese de Blainville, Quebec

brand new

the 1001 TECHNICO MARS-LUMOGRAPH "push-button" lead holder has a...

Lead Sharpener concealed in the cap

- Why be Satisfied With Ordinary Holders When You Can Have the Imported MARS-LUMOGRAPH TECHNICO at the Same Price?
- Modern Light-Weight Construction Features the MARS-LOCK CLUTCH with Perfect Grip!
- Easy to Dis-Assemble Completely. All Parts Replaceable!

Imported from Germany

Use 1904 Mars Lumograph Imported Drawing Leads

Sold at All Leading Drawing Material Dealers and Blue Printers

Write Today for Detailed Literature on the 1001 TECHNICO

J. S. STAEDTLER, INC.
53-55 Worth Street, New York 13, N. Y.
STAEDTLER SINCE 1662

Mead. I would also like to know their address. —P. S. MUMFORD, *V. P., American Machines & Metals, Inc.*

Ed—In reply to your comments on the article "Improving Engineering Department Operations" by States Mead, of Cresap, McCormick & Paget, we are sending along to you about the last of a reprint we have on Mr. Mead's article, plus other articles on the general problem of engineering management.

The firm of Cresap, McCormick & Paget is a management consultant firm with some of the largest industrial accounts in the country. For example, the Pennsylvania Railroad, Boeing Aircraft, Westinghouse Electric Corporation, and other big management companies. This is also the firm that last year did the report for the government on reorganization of the Justice Department. In addition, Mr. Cresap is a vice president of the Westinghouse Electric Corporation, in charge of company organization and management control.

The firm address is: Cresap, McCormick & Paget, 342 Madison Ave., New York.

Much Interest in Drafting Templates

To the Editor:

We are very much interested in obtaining the name and address of the source for the templates mentioned in your article, "Templates of Detail Profiles Promote Drafting Efficiency" in the November 1952 edition of *Product Engineering*. We are particularly interested in types 31, 32, and 35 mentioned on page 180.—*Electronics Div. Sylvania Electric Products, Inc.*

To the Editor:

Will you put us in touch with the manufacturer of the drafting templates as described in the article, "Templates of Detail Profiles Promote Drafting Efficiency" in the November issue of *Product Engineering*.—F. D. MANN, *Denver Blue Print Co.*

To the Editor:

Please send us the name of the company that will supply the special templates mentioned in the article on pages 178, 179, and 180 in the November 1952 issue of *Product Engineering*. — F. S. CHAPLIN, *Director, The Franklin Institute*

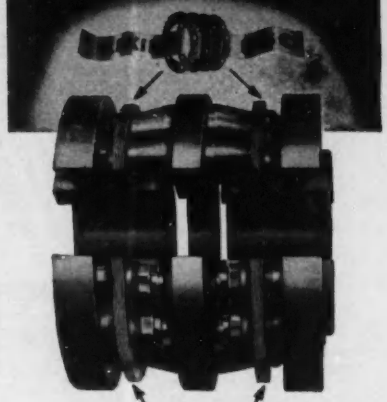
Ed—These templates are made by a west coast concern under the license of the Douglas Aircraft Co. We do not have the name of the manufac-

AVOID COSTLY SHUT-DOWNS!

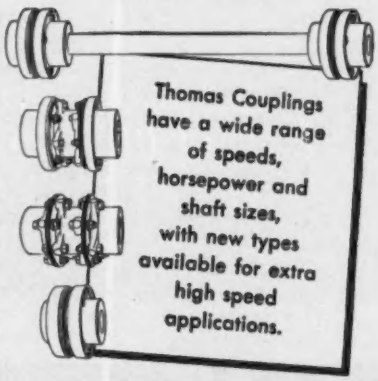
. . . your machines will last longer with Thomas Couplings

Distinctive Advantages of THOMAS FLEXIBLE COUPLINGS

- NO MAINTENANCE
- NO LUBRICATION
- NO BACKLASH
- NO WEARING PARTS



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings have a wide range of speeds, horsepower and shaft sizes, with new types available for extra high speed applications.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

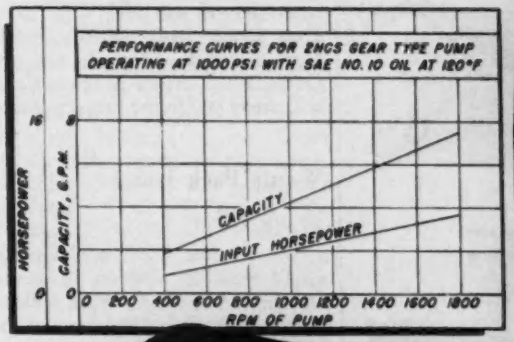
NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

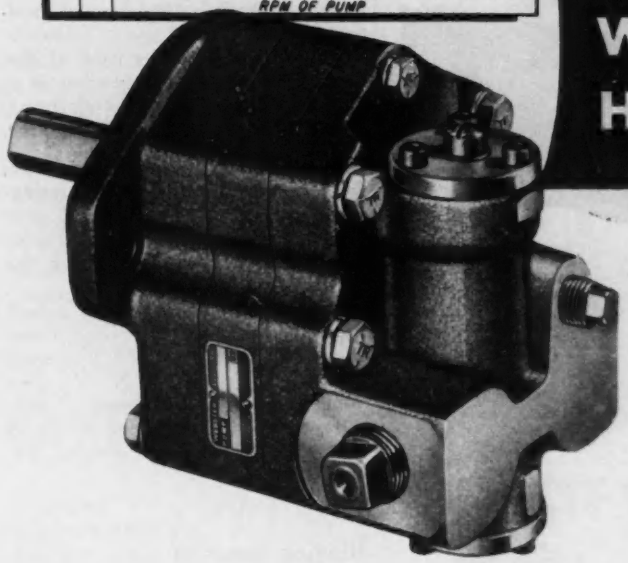
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

TYPICAL PERFORMANCE CURVE



For PROVEN PERFORMANCE and LOWEST COST

check the WEBSTER Line of Hydraulic Pumps



CHECK THESE FEATURES

- ✓ Exceptionally compact design.
- ✓ Wide selection of porting locations and mounting methods.
- ✓ Integral relief valve optional.
- ✓ Gear contour carefully selected for quiet operation.
- ✓ Shaft design to accommodate various driving mediums.
- ✓ Engineered and precision-built for economical performance.
- ✓ All materials carefully chosen for durability.
- ✓ Design permits use in pumping other liquids having a substantial oil base.

● It will pay you to get the facts about Webster Gear-Type Hydraulic Pumps before buying *any* pump. Here is a *complete line* of rugged, dependable pumps from 10 gph. to 10 gpm., engineered to operate efficiently at pressures up to 1000 psi. at speeds of 3600 rpm. or less—90 pumps of various designs and capacities to meet the widest range of requirements!

Webster pumps are the product of skill acquired during nearly a quarter-century of experience. They have established an enviable reputation for efficient, dependable operation. All Webster pumps lend themselves readily to many forms of adaptation—and to modification for special installations. All are available with built-in relief valve, if desired.

Whenever you require pumps for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications, we invite your inquiries. There is no obligation; just fill in and mail the coupon for further information.

Webster Electric Company, Racine, Wisconsin . . . Established 1909

Oil Hydraulics Division, Webster Electric Company,
Dept. PE-2, Racine, Wisconsin.
Send me information on Webster Hydraulic Pumps as checked:
Capacity (Approx.)_____gph. (or gpm.)
Pressure (Approx.)_____P.S.I.
Name and Title_____
Firm Name_____
Street Address_____
City_____ Zone_____ State_____

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE WISCONSIN

"Where Quality is a Responsibility and Fair Dealing an Obligation"

World's most powerful qualified turbojet conserves lubricating oil with high-efficiency mechanical shaft seals

It's the Westinghouse J40 turbojet aircraft engine — capable of developing thrusts equivalent to approximately 25,000 HP at today's jet flight speeds. Among its many performance "firsts", this engine has established an outstanding record in conservation of lubricating oil — actually cutting allowed oil consumption by 93%.

Sealol is proud that Westinghouse Electric Corporation incorporated Sealol Seals into this powerful turbojet engine which drives the McDonnell F3H "DEMON" and the Douglas F4D "SKYRAY" among others.

Sealol has specialized in the design and manufacture of seals for unusually rigorous operating conditions. These include processing tank agitator shafts, high pressure hydraulic pumps, process pumps in chemical and refining industry, centrifugal compressors and blowers, etc.

If you have a shaft-sealing problem, consult Sealol. Send blueprints and specifications to our engineering department — Sealol Corporation, 45 Willard Ave., Providence 5, R. I.

CHICAGO • CLEVELAND • LOS ANGELES • PHILADELPHIA
(In Canada: Lyman Tube and Bearings, Ltd., Montreal, Toronto, Winnipeg)

SEALOL

The Balanced Pressure Seal

turer, but if you will write to: Mr. Don Black, Mgr., Public Relations Dept., Douglas Aircraft Co., 3000 Ocean Blvd., Santa Monica, Cal., he will direct you to the proper source.

Wants Back Issues

To the Editor:

We are interested in obtaining an article entitled, "Nylon in Bearings and Gears" by W. C. Wall, which appeared in the July 1950 issue of *Product Engineering.*

I would appreciate a copy of that issue if possible, or suggestions as to how I can obtain a reprint of the article. —*Day & Zimmermann, Inc.*

Ed—The only way we can supply you with a copy of "Nylon in Bearings and Gears" from the July 1950 issue is to have the pages photostated from our bound volume. The cost for this service is 40¢ per page.

You may be able to secure a back copy of this particular issue from: H. W. Wilson Co., 950 University Ave., New York 52, N. Y. This company deals in back issues of many industrial publications, and we know they maintain a file on *Product Engineering.*

Binding Issues of *Product Engineering* For File Reference

To the Editor:

I am considering binding my collection of past issues of *Product Engineering.* Do you know of anyone who specializes in this work and what the cost will be?

Also, would it be possible to bind into your magazine, card weight sheets which are printed in the form of index cards for each of the major articles of the issue? The cards should be approximately 3x5 inches so that they may be torn out and then filed for future reference.

I am sure that your other readers would appreciate this short cut method of indexing the wealth of information in each issue of *Product Engineering.*

—MOSHA CORNFELD,
Los Angeles, Calif.

Ed—There are many concerns that will bind up pages from *Product Engineering* for file reference and at not too great a cost. We would imagine that you could have somewhere between 1200 to 1500 pages bound in a cover for around 15 to 20 dollars.

Rather than tell you of a concern

here in the East, what we would suggest you do is to call the local library who have much of this work. Perhaps they could suggest a bindery.

Insofar as your other suggestion is concerned, it is impractical for us to bind into the magazine heavy index cards for each issue of the publication. The reasons are: (1) The number of cards required would "spread" the book, and (2) would add substantially to our mailing cost. However, the first item would perhaps be most important. The suggestion does have considerable merit and is one that we have discussed in the past on several occasions.

ERRATA

September 1952, page 202. *Strain History Determines Low Temperature Properties of Ingot Iron.* Paragraph 2, line 3.—"Minus 250 F" should be "minus 320 F." Paragraph 5, line 2—"removes some of the brittleness" should read "removes some of the low-temperature brittleness." Paragraph 7, line 3—"minus 250 F" should read "minus 320 F." Figure on page 203—"minus 78 F" should read "plus 78 F."

September 1952, gatefold opposite page 182, *High Speed Photography in Design.* Color code at top should be reversed. Opposite black line it should read, "Optical components optional in the type of camera illustrated;" opposite red line it should read, "Optical components essential in the type of camera illustrated."

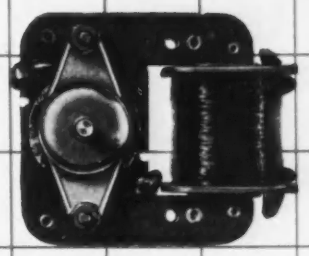
In Our Readers Say Column of the October 1952 issue of PRODUCT ENGINEERING a request was made for more information on a new process known as hydro-forming, a method of drawing simple or intricate shapes in all kinds of sheet metal. We neglected to mention the Cincinnati Milling Machine Co., Cincinnati 9, Ohio, who also use this process. Presses are now capable of handling blank diameters up to 26 inches.

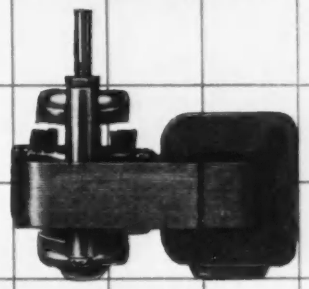
December 1952, page 196, *New Low-Cost Process Turns Titanium-Oxide Into Titanium.* Middle of third column—"the metal has a purity of 0.992 to 0.995 percent. Should read "99.2 to 99.5 percent."

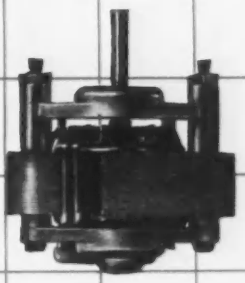
December 1952, page 217, *Using Taylor's Series to Solve Spiral Gear Problems.* Top of second column—in the second equation for f (x), the factor h in the last term should be squared.

Bathroom heaters
Sound recorders
Phonographs
Record changers
Kitchen exhaust fans
Small unit heaters
Timing devices
Window ventilators
Business machines
Air pulsators
Furnace controls
Vending machines
Blowers

wherever you require 1/50th to 1/500th horsepower







SPECIFY

Smooth Power small motors

Full-rated power packed into a compact package . . . long-life dependability at mass-production cost . . . General Industries' *Smooth Power* Small Motors combine all the features you require to power practically any application requiring 1/50th to 1/500th H.P.

The four types illustrated permit you to fit *Smooth Power* Motors into your present production or future designs. Write for design data and specifications.

. . . also these models

Model C—2-pole A.C. induction type

Model O 2-pole reversible capacitor type (for 6 or 12 or 24 volt A.C. only)

Model D 4-pole A.C. induction type

50th ANNIVERSARY 1903 . . . 1953

The GENERAL INDUSTRIES Co.
DEPARTMENT MM • ELYRIA, OHIO

Take a good look at this New Powerhouse!

The ONAN "CW" Electric Plant

5,000 or 10,000 WATTS

Designed to fit every application better . . . standby, portable, mobile and stationary. *Whatever* your need for electric power, the new Onan CW-5 and 10 give you top performance and value!

Here for the first time are 5 and 10KW electric plants powered by revolutionary, new air-cooled gasoline engines, *designed and built by Onan exclusively for electric plant use!*

Both engines are 1800 R.P.M. The 13HP Onan engine which powers the CW-5 and the 20HP Onan engine used for the CW-10 weigh much less than general-purpose engines, and are amazingly compact. Built to deliver dependable, trouble-free service in heavy-duty use. Two-cylinder, alternate-firing design assures smooth, vibration-free power. New, quiet, highly-efficient vacuum air cooling drives out all heated air through *one* side duct. The same duct carries exhaust gases, simplifying installation.

Impulse-coupled, high-tension magneto ignition for quick starting under all conditions. Both models in all standard voltages 60-cycle A.C., single or three phase.

***Far Out Front* in design and engineering**

● Twin-cylinder, horizontally-opposed, air-cooled, alternate-firing engines ● Aluminum-alloy cylinder heads ● Extra-large, replaceable bearings ● Full-pressure lubrication, 6-quart oil capacity, oil filter ● Impulse-coupled, high-tension magneto ignition, radio suppressed ● Quiet, vacuum air-cooling of generator and engine ● Excellent accessibility; snap-off air housings ● High-performance generators ● Completely equipped with controls and instruments.

Write for folder and specifications

Onan ELECTRIC PLANTS

D. W. ONAN & SONS INC.

7853 UNIVERSITY AVE. S.E., MINNEAPOLIS 14, MINNESOTA

NEW BOOKS

An Introduction to Scientific Research

E. BRIGHT WILSON, *Prof. of Chemistry, Harvard University, 375 pages, 6 x 9 in. Published by McGraw-Hill Book Co., 330 West 42 St., New York 36, N. Y., $6.*

At one time scientific research was the sole province of colleges and universities. Today, almost every large company has a research facility probing basic problems in science. Such widespread activity, coupled with the government's mushrooming interest in research, has precipitated a shortage of trained research workers.

Professor Wilson has written this book as a guide for college graduate students about to enter into scientifiic research. He attempts to describe the mechanics of research that take so much of the new researcher's time. The book follows research procedure: It starts with the selection of a problem and ends with a chapter on preparing results.

Major chapters cover such fundamentals as: How to search the literature. (Most scientists feel that six hours in the library will save six months in the laboratory, providing you know where and what to look for.)

How to plan the experiment.

How to design the apparatus.

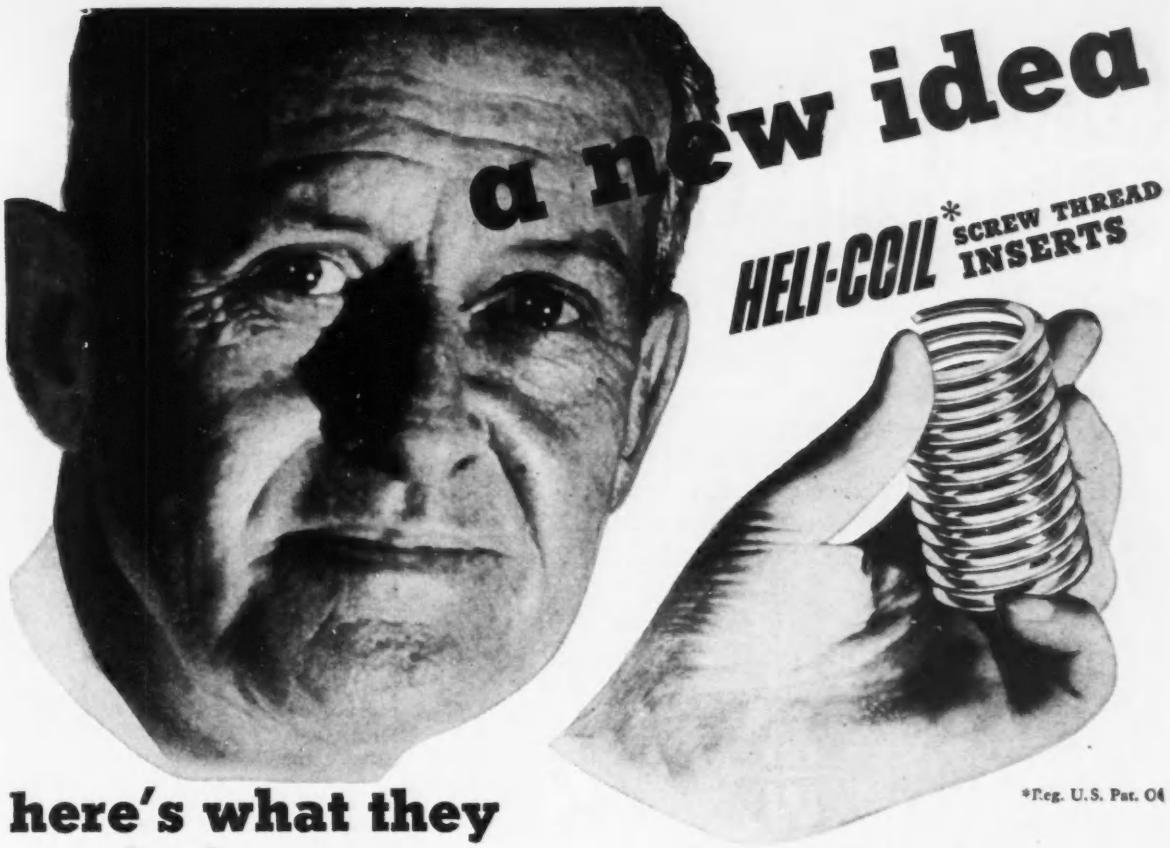
How to interpret data. (Considering the effects of randomness, probability, errors of measurement, etc.)

Control of Electric Motors

PAISLEY B. HARWOOD, *Vice Pres. in Charge of Engineering, Cutler-Hammer, Inc., 538 pages, 6 x 9 in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., $7.50.*

Since the use of electric motors in all phases of industry has expanded so greatly, the development of controlling devices for these motors has followed suit. This book, then, has been revised and expanded to keep pace with the latest developments and to present the most up-to-date information available on the design, construction, and application of controllers for all kinds of motors.

This third edition includes much of new information on: circuits, devices, and calculations used for the



*Reg. U.S. Pat. Of.

here's what they do for you

they save money because they strengthen threads and make *fewer* fastenings do the same holding job... they make *lighter* bosses and flanges practical... and they *save* weight in *two* ways: (1) by permitting use of cap screws instead of bolts and nuts or studs and nuts; (2) by putting smaller, shorter, fewer cap screws to work than required for unprotected threads.

they protect your product from thread wear and stripping for life in every kind of metal, in plastics or wood. They preserve your customer good-will by preventing complaints about thread failure.

they meet fast production line requirements... Simply drill and tap as usual, then wind in **Heli-Coil** Inserts for *permanent, armored threads.*

no other method is so simple, effective and practical—especially in aluminum and magnesium

So easy to use! Average time to install 3 seconds!

Drill...Hole is drilled in conventional way—right on production line. **Tap** ...Hole is tapped with *Heli-Coil* tap to receive insert—right on production line. **Install**...Insert is installed in tapped hole with hand or machine inserting tool —right on production line.

What *Heli-Coil* Inserts Are

Heli-Coil Inserts are precision formed thread liners of stainless steel or phosphor bronze wire, diamond-shaped in cross-section. They are available for National Coarse, National Fine and Unified threads, pipe threads and aviation and automotive spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

APPROVED FOR ALL MILITARY AND INDUSTRIAL USES

These and many other advantages can mean much to you. Why not convince yourself about **Heli-Coil** *Inserts for your own benefit. Return the coupon now and get all the facts.*

HELI-COIL CORPORATION

142 SHELTER ROCK LANE, DANBURY, CONN.

☐ Please send *Heli-Coil* Catalog and Sample *Heli-Coil* Insert.

☐ Attached is drawing of our product. Where do you recommend using *Heli-Coil* Inserts?

NAME_____ TITLE_____

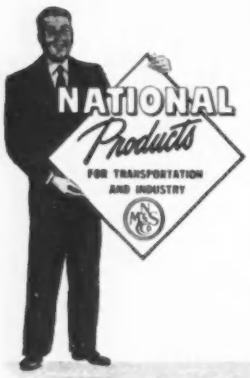
COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____ ©1964

Castings by National

selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.

These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

NORTHWEST · EATON · M W · Kelsey-Hayes · A-C · Budd · CATERPILLAR · American-Standard · TIMKEN Detroit AXLES · BALDWIN BLH LIMA-HAMILTON

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5345

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

SEE "This Moving World"

A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY Est. 1868

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO

regulation of voltage, speed, tension, etc.; numerous industrial applications; descriptions of electronic amplifiers, rotating regulators, and positioning servomechanisms; and basic principles of regulating problems (in a new chapter). New photographs are included, replacing the out-dated ones; new wiring diagrams have been specially drawn; and all the references have been revised and expanded. Included are 350 problems, plus factual data upon which hundreds of additional problems can be based. The whole book, in fact, has been revamped to meet the needs arising from this rapidly expanding phase of industry.

As in the previous editions, the arrangement of material is entirely by motor types. Describing the design, construction and application of controllers for electric motors, it begins with a general discussion of wiring diagrams, construction details, and pilot devices as applied to all kinds of motor control. The book is then divided into two sections—one on d-c motors and motor control, the other on a-c motors and motor control—in which each motor is thoroughly discussed. It covers completely the operation, characteristics, and application of each motor, the methods used to control it, and the actual design of the various types of control for that particular motor.

High-Energy Particles

BRUNO ROSSI, *Prof. of Physics, Massachusetts Institute of Technology, 569 pages, 6 x 9 in. Published by Prentiss Hall, 70 Fifth Ave., New York 11, N. Y., $12.50.*

Behind the sea of activity on atom bombs and atomic powerplants an army of researchers are delving into the basic fundamentals of particles so the builders of so-called atomic devices will be able to understand and control the power-packed reactions that are the heart of the atomic age. One of the major obstacles to this research has been a lack of good reference sources on high-energy particles and their reactions.

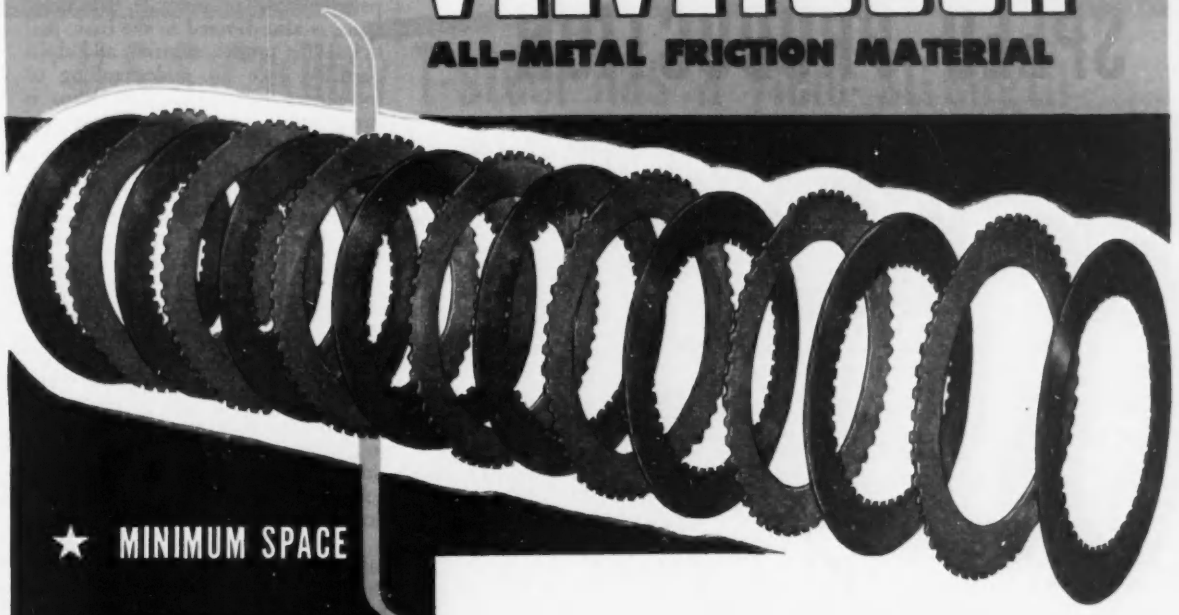
Physicists have had to spend much of their time pouring over a host of journals and articles to develop background material for their own experiments. "High Energy Particles" attempts to centralize present knowledge of high energy phenomena and research methods peculiar to the field.

The book is for the serious researcher, written on a high level with the complex mathematics familiar to

FOR COMPACT CLUTCH AND TRANSMISSION DESIGN

specify **VELVETOUCH**

ALL-METAL FRICTION MATERIAL



★ MINIMUM SPACE

★ LONGER LIFE

★ ADDED SAFETY

★ PEAK DEPENDABILITY

Velvetouch

More and more, experienced engineers are designing Velvetouch into their clutches and automatic transmissions. Because all-metal Velvetouch gives you established advantages impossible to obtain with non-metallic friction material.

You get maximum compactness...thanks to exclusive, advanced manufacturing techniques that permit friction surfaces just .020" thick like those pictured above. And you get this big design advantage at no sacrifice in performance... for all-metal Velvetouch runs cooler, withstands higher unit pressures, is impervious to oil or grease, delivers peak operating uniformity under the most severe conditions.

Our technicians, backed by the world's largest laboratory devoted exclusively to developing and testing all-metal friction products, are anxious to help you solve your clutch and brake problems. Just phone our nearest office, or write—

THE S. K. WELLMAN CO • 200 EGBERT RD • BEDFORD, OHIO

THE S. K. WELLMAN CO. SALES OFFICES AND WAREHOUSES

* ATLANTA—119 14th St., N. E., Atlanta 5, Georgia

** DETROIT — 18822 James Couzens Highway, Detroit 21, Mich.

* SAN FRANCISCO—424 Bryant Street, San Francisco 7, Calif.

* CHICAGO—1500 South Western Ave., Chicago 8, Illinois

* LOS ANGELES—1110 South Hope St., Los Angeles 15, Cal.

* TORONTO, ONTARIO — The S. K. Wellman Co. of Canada, Ltd., 2839 Dufferin St.

* CLEVELAND—200 Egbert Rd., Bedford, Ohio

* PHILADELPHIA—1545 West Bellfield Ave., Philadelphia 41, Pa.

** WASHINGTON—1101 Vermont Ave., N. W., Washington 5, D. C.

* DALLAS — 3407 Main Street, Dallas 1, Texas

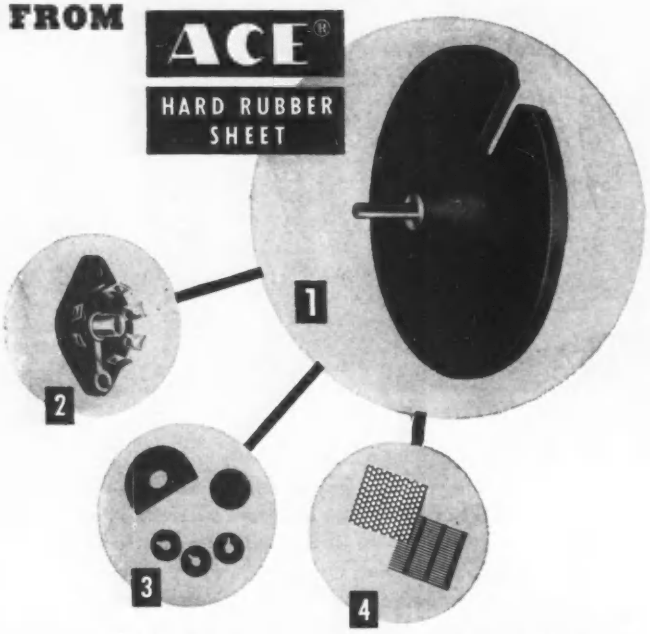
* PORTLAND—838 N. W. 18th Ave., Portland 9, Oregon

** EXPORT DEPARTMENT—8 South Michigan Ave., Chicago 3, Illinois

* SALES OFFICE AND WAREHOUSE ** SALES OFFICE

where HARD RUBBER is right... use it!

HOW TO
SPEED PRODUCTION
WITH PARTS PUNCHED
FROM ACE® HARD RUBBER SHEET



IDEA 1 Cut from strong, wear-resistant ACE hard rubber sheet, this precision-machined meter piston spends years under water without warping or swelling.

IDEA 2 Intricate tube socket assembled at low cost from tiny punchings of Ace X-2-B. Strong, rigid. Dielectric strength 415 v/mil (60 cycles); Power factor 0.6% (1 megacycle).

IDEA 3 Chemical resistant, strong (up to 10,000 psi. tensile), high-dielectric, wear-resistant ACE hard rubber sheet is ideal for myriads of small parts.

IDEA 4 Can you use perforated or slotted hard rubber sheet as screens, strainers, separators, containers, etc.?

ACE hard rubber sheet punches and machines easily . . . cuts time and costs both! It's available in many grades and finishes, sizes to 24" x 50", as thin as 0.005". Ask for further details today.

American Hard Rubber Company
93 WORTH STREET • NEW YORK 13, N. Y.

nuclear physicists. The layman or casually interested reader will find hard going from the first page.

What particles are considered? Of course the neutron, the all-important particle of the nuclear pile. But much space is also devoted to the basic particles—the proton, electron, and alpha particle—since an understanding of these particles and their reactions is fundamental to an understanding of nuclear physics.

Certainly one of the most important aspects of this book is the extensive coverage of the meson, that elusive high energy particle in cosmic rays. Since Japanese scientist Yukawa first predicted its presence in 1933, physicists have felt that the meson holds the key to the explanation of the peculiar forces acting in the nucleus. Scientists have expended much effort in trapping this particle for study. In fact the desire to create this particle in the laboratory is the prime motivation for the many billion-volt atom smashers being built in the United States today.

In this section, Professor Rossi compiles much of the valuable information that was previously so laborious to obtain: properties of the five different types of mesons, decay information, disintegration properties, nuclear interaction, production data, etc.

Two of the meatiest chapters are devoted to experimental techniques in the field, and a discussion of experimental results. Typical discussions: designed and operation of cloud chambers, efficiency of Geiger-Mueller and proportional counters, and detection of particles with photographic emulsions.

The appendix concentrates on the mathematical expressions frequently used in this field. There is a quick review of the basic relatavistic equations, development of the Poisson formula for determining statistical errors, and discussions of the off-appearing Laplace, Mellin and Gold integrals.

As a handbook-type publication, "High Energy Particles" undoubtedly will serve a valuable function in laboratories devoted to basic research in nucleonics.

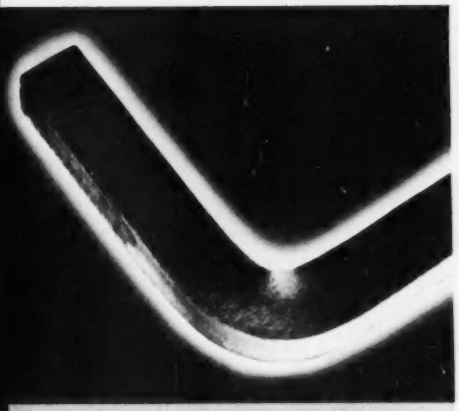
Training the Voice for Speech

C. RAYMOND VAN DUSEN, *University of Miami, 276 pages, 6 x 9 in. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y., $4.*

This basic text in voice and diction, completely rewritten, provides a practical, understandable, and down-to-earth approach for the student who

New facts for your file on U·S·S CARILLOY STEELS

U·S·S Carilloy T-steel has a yield strength of over 90,000 psi., but you can weld it as easily as ordinary carbon steel



This specimen, flame-cut from 1" Carilloy T-1 plate was chilled to -98°F. and then bent to a full 90° angle. Even though the raw, flame-cut edge made up the outer radius of the bend, there was no sign of failure!

● CARILLOY T-steel is unique. It's a very-high-strength steel that you can weld or flame-cut successfully with ordinary methods used for carbon steel. These operations do *not* lower T-steel's high yield strength. Therefore, you can design to the *full* 90,000 psi. with confidence that parts will retain all of their strength during later fabrication. What's more, T-steel can be readily welded or flame-cut in the field without special pre-heating or stress relieving.

T-steel was designed especially for heavy-duty parts that must operate under rugged service conditions. Despite its high nominal hardness of about 250 Brinell, it has an extremely low transition temperature and remains ductile and tough at the lowest atmospheric temperature. Specimens of T-steel have been flame-cut and then bent to a full 90° angle at -100°F. with no sign of cracking. Other very-high-strength steels would require elaborate and expensive heat-treating to pass such a test.

This remarkable steel is now being used in heavy earth-moving equipment, railroad cars, big water wheel generators, and other equipment that must stand tremendous abuse. In applications where tension is the principal stress, it lets you safely reduce the size and weight of heavily-stressed parts by as much as 50%. Since field welding and flame-cutting are possible, the difficulty and cost of making major repairs is materially reduced.

There are many cases where parts made of T-steel will be less expensive than the steel being used. It will pay you to examine every possible use for it in your equipment. Our experienced metallurgists can give you valuable tips on how and where to use it to best advantage. Just write to United States Steel, Room 2809-L, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

These welded pieces of T-steel broke outside the welds during tensile tests. The welds develop the full strength of the parent metal without special pre-heating or post-heating treatments.

MECHANICAL PROPERTIES OF U·S·S CARILLOY T-1 STEEL

Thickness	¼" to 2" incl.	Over 2" to 4" incl.	Over 4" to 6" incl.
Yield Strength .2% Offset (min)	100,000 psi	90,000 psi	90,000 psi
Tensile Strength (min)	115,000 psi	105,000 psi	105,000 psi
Elongation in 2", % (min)	18	17	16
Reduction of Area, % (min)	55	50	45
Thickness	**¼" to ½" incl.**	**Over ½" to 1" incl.**	**Over 1" to 2" incl.**
Cold Bend	180° D = 1t	180° D = 2t	180° D = 3t

(Testing in accord with A.S.T.M. recommended practices)

Here's where CARILLOY T-STEEL is now being used

- Tension Rods
- Highly-stressed shovel parts
- Ore-car bottoms
- Pole-end pieces for electrical generators
- Liners for heavy truck bodies
- Dredge buckets
- Wind Tunnel flex plates
- Hammer tie plates
- Bridge thrust plates
- Water wheel generator parts
- Butterfly valve liner plates

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on U·S·S STAINLESS STEEL

This ice cream cabinet, manufactured by Anheuser Busch, Inc., St. Louis, Mo., uses Type 430 Stainless Steel for the cabinet top.

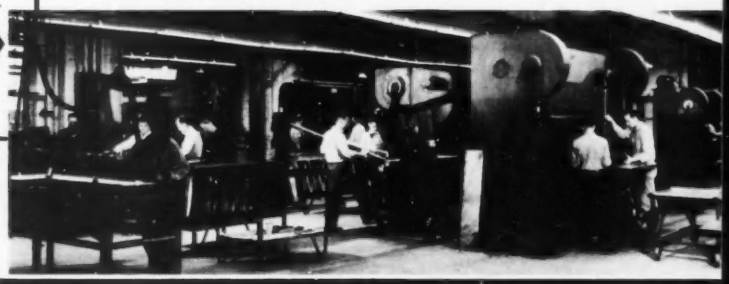
Freezer cabinet tops fabricated from U·S·S 17 (TYPE 430) Stainless Steel

● Here's another successful application of U·S·S 17 (Type 430) Stainless Steel—the grade available today that is best suited for a wide range of fabricating and end use requirements.

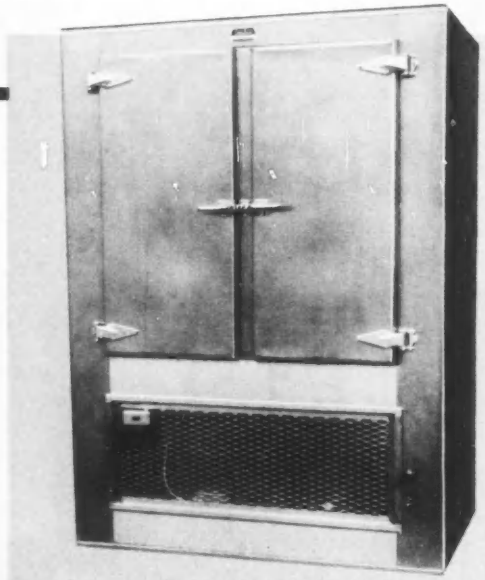
Anheuser Busch, Inc., St. Louis, Mo., is using polished sheets of Type 430 Stainless in fabrication of tops for frozen food and ice cream cabinets.

Frames for the glass tops are formed from .031″ material, and channel tracks are formed from .050″ material. Moldings for the tops are of .025″ Type 430 Stainless Steel. Bends of 90° are the most severe formations encountered in making these parts.

After months of experience in such fabrication, Anheuser Busch reports uniformly good results with Type 430 Stainless Steel.



Forming sheets of Type 430 Stainless Steel in manufacture of freezer cabinet tops at Anheuser Busch, Inc.



26-gage sheets of Type 430 Stainless Steel were used in manufacture of this refrigerator case by Zero Plate Company, Fort Worth, Tex. Material was processed by Rigidized Metals Corporation, Buffalo, N.Y.

Rigid-tex Type 430 Stainless Steel used for refrigerator case

● Zero Plate Company of Fort Worth, Tex., is another fabricator that has taken advantage of the qualities of Type 430 Stainless Steel for current production.

For the reach-in type of refrigerator cases it manufactures, Zero Plate Company uses 26-gage sheets of Type 430 Stainless Steel as processed by Rigidized Metals Corporation of Buffalo, N. Y.

Fabricating steps used by Zero Plate Company include forming, riveting and soldering, and the results — both in fabrication and end use — have been excellent.

Help with your design problems

If you would like to take advantage of available U·S·S 17 (Type 430) Stainless Steel for your product, our representatives will be glad to make suggestions for easier fabrication and the best end use. There is no obligation. Write to United States Steel Corporation, Room 2809-L, 525 William Penn Place, Pittsburgh 30, Pa.

USS

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on U·S·S HIGH STRENGTH STEELS

U·S·S COR-TEN corrosion resisting steel builds a complaint-proof tank for vacuum heating pumps

● Built by the Whittington Pump & Engineering Corporation, Indianapolis, Ind., the vacuum tank on this pump is unusual in several respects. Instead of the usual cast iron or plain steel construction this tank is made of welded COR-TEN steel with a yield point of 50,000 psi and having 4 to 6 times the resistance to atmospheric corrosion of mild steel.

How does it stand up in service? Although it is exposed internally to the corrosive attack of hot condensate at elevated temperatures and in a super-aerated condition, this COR-TEN steel tank has operated with no service calls, no failures or complaints for 13 years. Says the Superintendent of the hospital where the pump is operating, "The advantages of COR-TEN steel for this application are: no rust, no corrosion."

U·S·S COR-TEN Steel pays off in lift truck application by adding strength and abrasion resistance

● The Transitier Truck Co., Portland, Ore., builds a line of HiDuty Lift Trucks that can carry loads up to 3,000 lbs. and high lift them to 144 inches. For good reasons they switched to U·S·S COR-TEN steel for the channels of the inner elevating frames. These channels have a double function. They act as sliding guides on their outer surfaces, their inner sides serve as roller tracks. The mild steel channels originally used left much to be desired. They were subject to rapid abrasion on their outer surfaces and to indenting and swaging of the roller track surfaces.

Both these difficulties were entirely eliminated when COR-TEN steel was substituted for carbon steel plate in the same thickness. There have been no service complaints on this score since. In addition, the 50% greater strength of COR-TEN steel provides extra resistance to deformation which assures safer and more efficient operation when the elevating frame is extended.

U·S·S MAN-TEN Steel reduces weight 16%, makes earth scraper easier to handle, reduces fabricating costs, saves freight

● By using U·S·S MAN-TEN high strength steel in place of carbon steel in their "Hydro-Scoop" scraper, the Stockland Road Machinery Company, Minneapolis, Minn., has been able to reduce weight from 220 lbs. to 185 lbs. This 35 lb. weight saving facilitates operation both in the field and in the fabricating shop. Due to the fact that the lighter sections in which MAN-TEN steel was used permitted one man to handle the part instead of two, the cost of forming one angle item was considerably reduced. Additional savings were realized by the reduced cost of freight shipment, both on the steel to the plant and on the finished scrapers. Says the manufacturer, "Our welding and assembly costs are no greater in any respect than similar costs on carbon steel. We feel that the use of MAN-TEN steel has been highly advantageous."

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on U·S·S CARILLOY STEELS

Press manufacturer saves money on tools and gets better finished machining with pre-hardened, free-cutting Carilloy FC steel

● Verson Allsteel Press Co., of Chicago, now makes the dies for big press brakes from U·S·S CARILLOY FC steel instead of an ordinary die steel. Pre-hardened, free-cutting FC steel enables this important manufacturer to make harder, smoother dies that are easier to produce.

Here's what Verson says about the performance of FC steel: "This steel cuts much cleaner and more easily than the steel we had been using. As a result, our cutting tools last much longer and the dies are not damaged during machining—even though we are using a much harder steel (300 BHN instead of 250 BHN). In addition, we put a smoother finish on the dies.

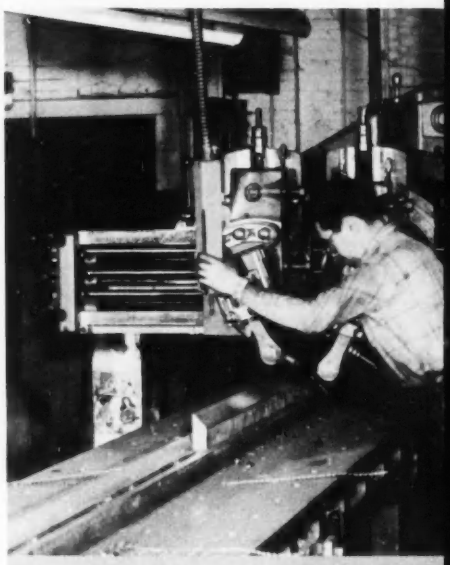
"Smooth finish is especially important in press brake dies, because metal is literally dragged over the die during forming. With these smoother dies, less pressure is needed to make a bend and the dies do not scratch the metal.

"Since the dies are harder, they work better on high tensile steels . . . often eliminate the need for re-treating the dies after use. We're well satisfied with FC steel."

CARILLOY FC is ready for use when delivered.

U·S·S CARILLOY FC steel comes to you already quenched and tempered to the hardness you require and doesn't require heat treatment after machining. It comes in all standard bar forms and sizes in a hardness range from 255 to 375 Brinell. Tensile strengths ranging from 125,000 to 175,000 psi. are available.

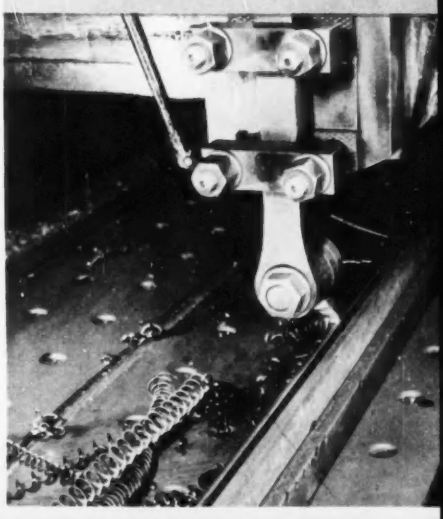
Our experienced metallurgists will be glad to discuss the possible applications of pre-hardened, free-cutting FC steel in your products. Just write to United States Steel, Room 2809-L, 525 William Penn Place, Pittsburgh 30, Pennsylvania.



Planing press brake dies from free-cutting Carilloy FC steel at Verson Allsteel Press Co. Carilloy FC is much easier to machine than the steel previously used, so tools last much longer. In addition, better machinability makes it possible for Verson to get a smoother finish and to use a harder steel for the dies. As a result the dies give better service.

Possible Applications for U·S·S CARILLOY FC steel

Arbors
Armature Shafts
Axles
Ball Bearings
Ball Races
Brake Press Dies
Blanking Dies
Bolts
Boring Bars
Bucket Teeth
Bushings
Cams
Chain Links
Chain Pins
Chuck Bodies
Chisels
Chisel Bushings
Clash Gears
Clutches
Collets
Connecting Rods
Connecting Rod Bolts
Coining Dies
Crankshafts
Cutter Bodies
Cylinder Head Studs
Dies
Die Bodies
Drift Pins
Drill Shanks
Elevating Screws
Embossing Dies
Expanding Mandrels
Feed Screws
Forge Hammers
Forge Rams
Forming Dies
Forming Rolls
Gauges
Gears
Guide Pins
Hammers
High Tempered Bolts
Hydraulic Rams
Jigs
Keys
Knuckle Pins
Knuckle Shafts
Lead Screws
Mandrels
Master Hobs
Molds
Nuts
Pinch Bars
Pinions
Pins
Pipe Cutter Wheels
Piston Rods
Pitman Screws
Plastic Molds
Pliers
Power Drive Bits
Propeller Shafts
Punches
Races
Racks
Ratchets
Reamer Bodies
Reamer Shanks
Rollers
Screws
Screw Drivers
Shafts
Shear Blades
Sleeves
Sleeve Shafts
Spindles
Spline Shafts
Spring Collets
Straightening Rolls
Studs
Swaging Rolls
Tap Shanks
Tool Bodies
Tool Post Screws
Trimming Dies
"U" Bolts
Universal Joints
Valve Studs
Worms
Wrenches



USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

wishes to acquire a better speaking voice and to improve his ability to express himself clearly and distinctly.

All basic processes of speech production are included, together with chapters on ear training, vocal pitch, loudness, quality, speech rhythm, and other related topics. Training exercises are given in chapters on relaxation, posture and breathing.

Advanced Mathematics in Physics and Engineering

A. BRONWELL, *Prof. of Electrical Engineering, Northwestern University, 475 pages, 6 x 9 in. Published by McGraw-Hill Book Co., 330 West 42 St., New York, 36, N. Y., $6.*

This new text presents a mathematical foundation in the principal branches of advanced mathematics which are used throughout physics and engineering. Clarity and understanding are primary considerations, although a reasonable degree of mathematical rigor has been achieved.

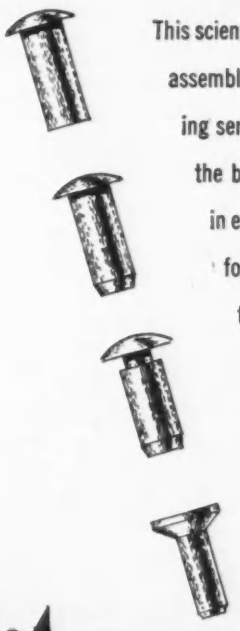
The fundamental physical laws in many of the more important areas of physics and engineering are expressed in general form. These become the springboard for the development of vast areas of applications. The text shows how the fundamental formulations simplify to special cases which usually form the starting point in the solution of problems in physics and engineering. The underlying unity in the methods of mathematical analysis in the various fields of physics and engineering are emphasized.

The topics include infinite series; Fourier series and the Fourier integral; ordinary differential equations; series methods of solving differential equations, including the Bessel, Legendre, and associated Legendre equations; partial differentiation; Lagrange's equations; Hamilton's principle, vector analysis; functions of a complex variable; and Laplace transforms.

A distinctive feature of this book is a chapter which presents a unified treatment of the solutions of a broad classification of linear partial differential equations. These include Laplace's equation, the wave equation, both with and without energy dissipation, the heat flow and chemical diffusion equations, and others. These equations underlie much of the theory of physics and engineering, including such fields as fluid dynamics, heat flow, vibration in systems with distributed elements, electromagnetic theory, etc. Solutions of the differential equations in various coordinate systems are obtained in the form of characteristic

...when the Milford Method may save you thousands of dollars in costly fasteners and assembly!

ask about the Milford Method



This scientific approach to product and parts assembly is a fastener-engineering consulting service which analyzes your needs at the blueprint stage...before you invest in expensive tools and dies! It projects for you the right fastener. Look into the economies of the "MILFORD METHOD" now. Send your blueprints and samples for analysis and planning by the "MILFORD METHOD", or write for the "Milford Method" brochure today.

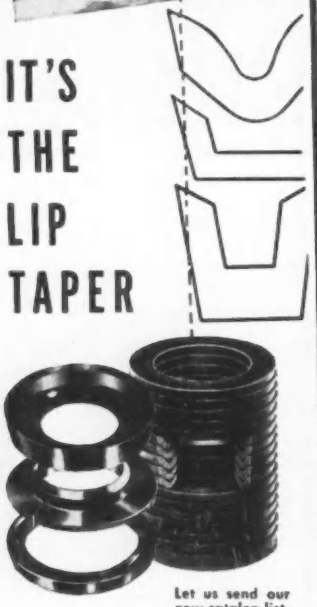
the MILFORD RIVET & MACHINE CO.
EST. 1919

MILFORD, the name to rivet in your memory for fasteners.

---- Bridgeport Ave., Milford, Conn.
---- Illinois Ave., Aurora, Ill.
---- W. River St., Elyria, Ohio
---- Platt Street, Hatboro, Penn.
---- So. Palm Ave., Alhambra, Calif.

The Superiority of Periflex Packings begins with Mold Engineering!

IT'S THE LIP TAPER



Let us send our new catalog listing mold data.

Sufficient interference to produce an efficient seal and at the same time minimum frictional drag on moving surfaces has been accomplished by Periflex. Careful attention is given in our shop to maintain close tolerances and special design features in mold manufacture.

Periflex Inc.

HAZEL PARK • MICHIGAN

functions. It is then a relatively simple matter to select the proper characteristic function for a given static or dynamic problem.

Chapters are devoted to the development of fundamental principles in the following areas: vibration in lumped and distributed element systems; heat flow; fluid dynamics, of both compressible and incompressible fluids; and electromagnetic theory. One of the chapters deals with the various criteria for stability of electrical and mechanical systems, including the Routh-Hurwitz criterion, the Nyquist criterion and others.

Problems have been carefully chosen to supplement the text material with additional information. They are designed to increase the mathematical facility of the student, as well as to give him a tangible understanding of the applications of mathematics in physics and engineering.

Hydrometallurgy of Base Metals

G. D. VAN ARSDALE, *Editor-in-Chief. Prepared with the assistance of the Door Company staff.* 370 *pages* 6 x 9 *in. Published by McGraw-Hill Book Co.,* 330 *W.* 42 *St., New York* 36, *N. Y.,* $9.50.

How to recover base metals by leaching is fully and practically shown in this book, with dependable facts from the wide experience of the editor and a group of specialists. With special reference to copper, it gives much helpful technical and economic information on the hydrametallurgy of copper, lead, zinc, antimony, cadmium, vanadium, uranium and radium.

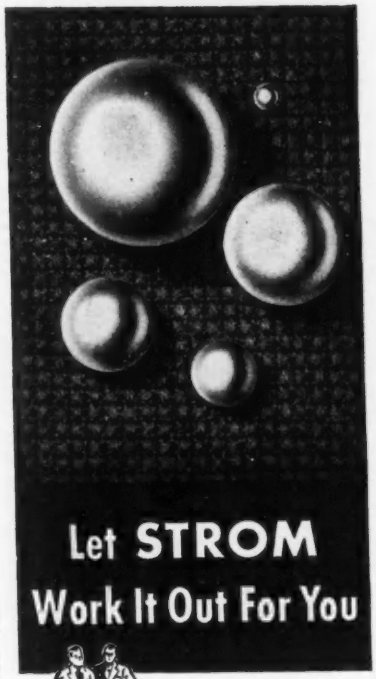
Processes and plants are described, and operating data is included from the field, facts on equipment and materials of construction, economic considerations, and preparatory steps, including crushing, grinding, and roasting. Here, too, is a complete treatise on the chemistry of leaching, and a study of the history, cost, and future of the leaching process.

Metal Data

S. L. HOYT, *Technical Advisor, Battelle Memorial Institute,* 526 *pages,* 6 x 9 *in. Published by Reinhold Publishing Co.,* 330 *W.* 42 *St., New York* 36, *N. Y.,* $10.

This second edition, similar in form to its predecessor, not only includes the most recent information available, but offers a wealth of new data on such topics as hardenability

a metal ball PROBLEM?



Let STROM Work It Out For You

Whether it is a precision ball bearing or one of the other many ball applications in industry, your problem will not be entirely new. Strom has been in on many ball problems and knows the importance of the right ball for the job.

Strom has been making precision metal balls for over 25 years for all industry and can be a big help to you in selecting the right ball for any of your requirements. In size and spherical accuracy, perfection of surface, uniformity, and dependable physical quality, there's not a better ball made.

Strom STEEL BALL CO.

1850 So. 54th Ave., Cicero 50, Ill.

Largest Independent and Exclusive Metal Ball Manufacturer

of H-Steels, the recently developed Super Alloys for high-temperature stress members, and other new alloys.

The original purpose of the book has been adhered to—select important data from reliable sources, and present them to metallurgists and engineers in a form usable for daily reference. As a result, the bulk of the material is offered in tabular form with a minimum of descriptive text. Nearly 700 tables and graphs include useful working information on such metallic properties as tensile strength, hardenability, thermal expansion, creep strength, endurance limit and yield strength at normal, subnormal, and elevated temperatures, and for various conditions of mechanical treatment. Numerous special features include a listing of commonly used test bars, hardness tests, corrosion data, conversion factors, applications of materials and the properties of elements.

Data is given for steels—including wrought, heat treated, cast and stainless, nonferrous alloys such as copper, aluminum, magnesium, lead and nickel, plus many of the less common metals like antimony, beryllium, bismuth, cadmium, tungsten, titanium, zirconium, etc.

The final chapter includes general data on such topics as the following: The periodic system; simple tests for identifying metals; heat content of metals; ASTM gram size charts; and many others.

Electrical Code Diagrams

B. Z. SEGALL 8½ x 11 *in. Published by McGraw-Hill Book Co.*, 330 *W.* 42 *St., New York* 36, *N. Y.*, $12.50.

This is the second of a two-volume series that is based on the 1951 edition of the National Electric Code. Volume I consisted of two chapters: Wiring Design and Protection; Wiring Methods and Materials. This volume contains four chapters as follows: Equipment for General Use; Special Occupancies, Special Equipment; Special Conditions; and Communication Systems. By showing diagramatically one or more illustrations for each code rule, the book clarifies just how the rule may be applied. Typical applications are also listed.

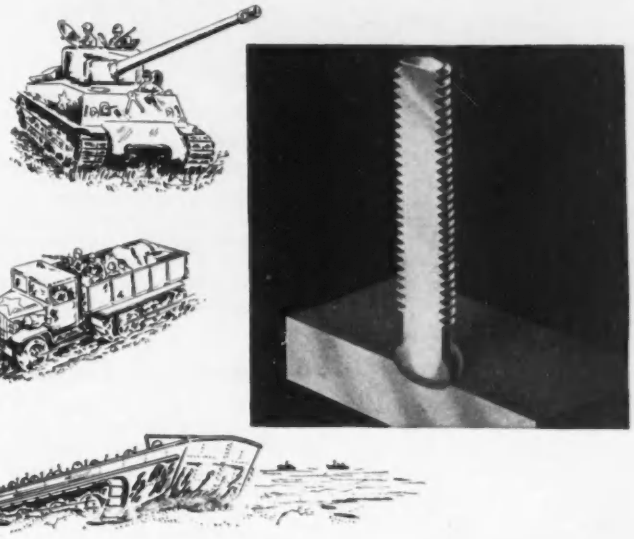
The section on equipment for general use includes such items as: flexible cords; lighting fixtures; appliances; motors and controllers; generators, transformers; capacitors; resistors and storage batteries. The Special Occupancies chapter discusses hazardous locations, garages, theaters, motion-picture studios, etc.

The Special Equipment chapter

improved stud welding
through **K S M** engineering

COST OF ARMORED VEHICLES LOWERED BY

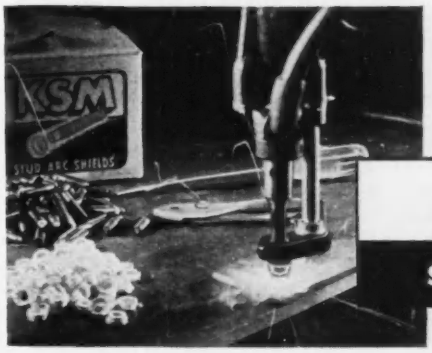
KSM STUD WELDING



The slow, expensive method of drilling and tapping armor plate for the numerous parts, covers and wireways which must be fastened in armored vehicles has been largely replaced by fast KSM stud welding. Production costs are reduced because KSM stud welding is an inherently faster method. In addition, time consuming rework, frequently required in drilling and tapping due to the characteristic variations in physical properties of armor plate, is eliminated.

The success of stud welding on armor plate is largely due to KSM research. KSM engineers developed a simple method of post-heating to stress relieve the immediate area. This gives base welded material greater strength than that of the fastener.

KSM engineering often reduces fastening costs and improves results. Ask for specific information in terms of your needs. Write KSM Products, Inc., Merchantville 8, New Jersey.

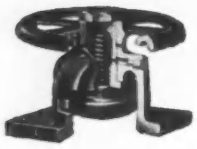


KSM
STUD WELDING

for valving corrosive and "hard-to-handle" fluids . . .

HILLS-McCANNA

offers over 20,000 different "custom-made" assemblies on a standardized basis

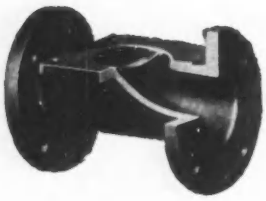


32 standard operators

Methods of operation for Hills-McCanna Valves include hand-wheel and lever operators, sliding stem, air and hydraulic cylinders, diaphragm motors and electric motors in a variety of types.

14 standard diaphragms

Diaphragms, the heart of Hills-McCanna Valves, are offered in the widest choice to best suit your individual needs; 5 types of rubber, 3 of Neoprene plus Hycar, butyl, Tygon, Compar, special polyethylene and Kel-F.



48 standard body materials

Bodies for Hills-McCanna valves are furnished in cast iron, with or without such linings as rubber, glass, lead, etc.; in any machinable alloy or in such materials as Karbate, stoneware, porcelain, etc.

By offering such a broad selection of operators, diaphragms and bodies, Hills-McCanna is able to furnish so many standard combinations that the user is in the position of being able, in most cases, to find the exact valve that best fits his individual requirements. There is virtually never any need to adapt to your service a valve developed for someone else's needs.

The 36 page catalog No. V-52 gives full details on all Hills-McCanna Valves. Write for your copy. HILLS-McCANNA CO., W. Nelson St., Chicago 18, Illinois.

HILLS-McCANNA

saunders patent diaphragm valves

Also Manufacturers of Proportioning Pumps
Force Feed Lubricators • Magnesium Alloy Castings

gives data on such items as signs and outline lighting, cranes and hoists, electric welders, sound recording equipment, induction and dielectric heating equipment, and machine tools. The Special Conditions section includes emergency lighting, circuits and equipment operating at more than 600 v between conductors, circuits and equipment operating at less than 50 v; remote-control, low energy power and signal circuits, and outside wiring.

The last chapter, Communication Systems, shows communication circuits and wiring details plus code rules for radio equipment.

Metadyne Statics

JOSEPH M. PESTARINI, *Lecturer, MIT and Columbia Univ.* 415 *pages,* 6 x 9 *in. Published jointly by the Technology Press of Mass. Institute of Technology and John Wiley & Son, Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.* $9.

This is a fundamental discussion of a new group of electric machines by the man who first recognized their common properties and potentialities. Certain of these generalized direct-current machines, or metadynes, may, without too great liberty, be called electromechanical vacuum tubes. This concept carries major implications since many versions of the generalized metadyne have already an established function throughout the whole range of high-performance automatic control systems.

Metadynes are usually used in systems of machines rather than individually as is conventional machinery. These systems can be designed to absorb power under a prescribed relationship between torque and speed, as well as response time. They are applicable to electric locomotives, rolling mills, cranes, sources of electric power for distribution systems, amplifiers, transformers, generators etc. They are designed from a synthesis standpoint with the necessary characteristics built into the components. This procedure contrasts with the conventional method of using machines that have inherent characteristics and that have to be closely regulated by feedback techniques to get the desired behavior.

Dr. Pestarini's approach to the analysis and design of these machines is so general—permitting arbitrary distribution of windings and brushes around the machine—that an almost unlimited range of characteristics relating speed, voltages, torque and currents can be obtained.

Many of these metadyne systems use

"constant current" or utilize generators or rotating transformers having nearly constant but drooping current characteristics. A wide variety of machines is available as components for these systems, and their characteristics can be modified by feeding into their multiple fields signals from other parts of the machine system. When these machines are used thusly, other beneficial and useful characteristics arise, such as ease of regenerative-braking, limited short-circuit currents, and reduced machine size for prescribed horsepower outputs.

The Principles of Physical Metallurgy

GILBERT E. DOAN, *Mgr. of Metallurgical Research, Koppers Co., formerly Prof. of Metallurgy, Lehigh University,* 331 *pages,* 6 x 9 *in. Published by the McGraw-Hill Book Co.,* 330 *West* 42 *St., New York* 36, *N. Y.,* $5.50.

As in earlier editions, the author approaches the subject from the standpoint of classical physical chemistry and physics. Beginning with the states of aggregation, the book presents a coherent and organically unified account of the behavior of metals under the influence of the operations which are performed upon them in the metal fabricating and manufacturing industries.

The basic principles of metallic behavior are stressed over the particular alloys or processes. However, the student must know these alloys and learn the basic processes and problems involved in their use in order that he may fully understand their relationship to fundamental principles. For this reason, separate consideration of the commercial aspects of the major metals and alloys is given briefly. For it is of as much importance to the engineer that he know how to convert the principles to practical application as it is to know the principles.

Metallurgic properties are now explained as far as possible in terms of atoms and electrons, replacing the mere comparison of metals as to these properties without practical knowledge as to their probable use and proper selection.

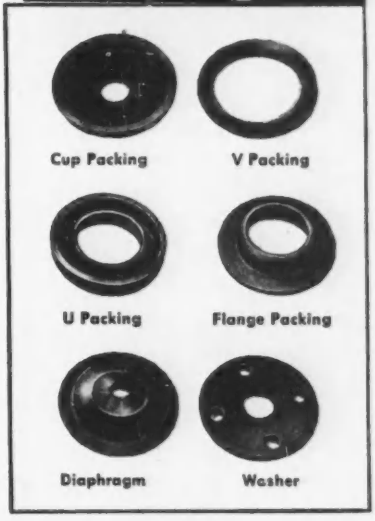
The author has given significant attention to the up-to-date features of the book by the revision of material on mechanisms of deformation and annealing in accord with recent findings. New casting techniques have been added, including investment casting and directional solidification methods for sand casting.

MARSH research leads again with a new *improved* quality impregnated mechanical leather!

Marsh leads in better Leather Packings, because –

- Only packing leather specifically tanned to Marsh rigid specifications is used.
- Marsh continuing research on impregnations and quality control give you new packing material values – to improve the efficiency and acceptance of your products.

Marsh research has developed new, tougher – wear, age and extreme temperature resistant – mechanical leather packings which combine resilience and tightness with low friction.



ENGINEERING AND CONSULTING SERVICE

If you seal oil, water, air, vacuum, gas, gasoline, naptha, alcohol or other fluids, ask Marsh for field engineering service.

FEATURES: Low coefficient of friction — both static and running, greater wear resistance, tighter sealing, better high and low temperature stability, improved lubrication potentials, longer life.

• Write for Engineering Handbook and technical literature

C. W. MARSH COMPANY

Main Office and Factory . . . Muskegon, Michigan

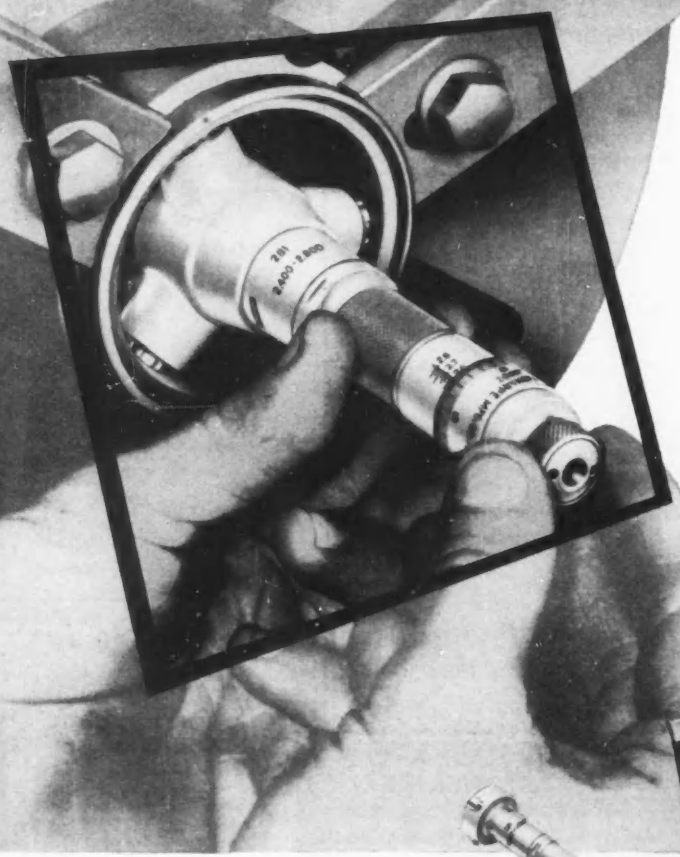
• SALES OFFICES •

75 E. WACKER DRIVE, CHICAGO 1, ILLINOIS
101 PARK AVE., ROOM 1730, NEW YORK 17, NEW YORK
1900 EUCLID AVENUE, CLEVELAND 15, OHIO

NEW INTRIMIK

Internal Tri-point Micrometer

Measures **any** Size Bore or Hole within range of tool... ***without masters***



Now you can realize new economies and speed by measuring bores and holes *directly!* The new Brown & Sharpe Intrimik Internal Tri-point Micrometer gives you a handy means of measuring in increments of .0001" on bore sizes from .275" to .500", and in increments of .0002" on bore sizes from .500" to 4.000". It's a big time and money saver... eliminates the need for expensive plugs and setting rings. Every feature for convenience, precision, and long service life is incorporated in its design and construction. Write for new illustrated Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

Extensions are available for all size Intrimiks to facilitate measuring deep holes.

Furnished as individual tools and in sets

WE URGE BUYING THROUGH THE DISTRIBUTOR

Brown & Sharpe B·S

Glass keeps market for bubblers "bubbling"

Another example of how glass by CORNING improves product performance

Bubbles aren't too solid a foundation on which to build a business but they have worked fine for The Meriam Instrument Co.

They manufacture Sight Feed Bubblers. At first, they were used for the continuous operation of tank liquid level gauges. Then, Meriam saw a much wider market for this product —to purge lines, give visual indication, note the presence of harmful gases and in conjunction with flow meter measure of corrosive materials, to eliminate the problem of satisfactory sealing fluids.

To make Sight Feed Bubblers adaptable for all of these services, Meriam engineers got in touch with Corning. Out of this came transparent corrosion-resistant PYREX bowls made to close tolerances for operation up to 50 psi. Noted for its resistance both to corrosion and thermal shock, PYREX brand glass No. 7740, provides an economical solution to the problem.

Doubtless your problem *is* different. But if glass in any shape or form can help to solve it, check with Corning. As a means of bringing you up-to-date on glass, we'd be happy to send you "Glass, its increasing importance in product design." It contains a digest of the characteristics and types of glass available with useful tabular data. Use coupon below.

Send for this 12-page illustrated idea book, "GLASS—its increasing importance in product design." The coupon is for your convenience.

Corning means research in Glass

Corning Glass Works
Dept. PE-2, Corning, N. Y.

PYREX

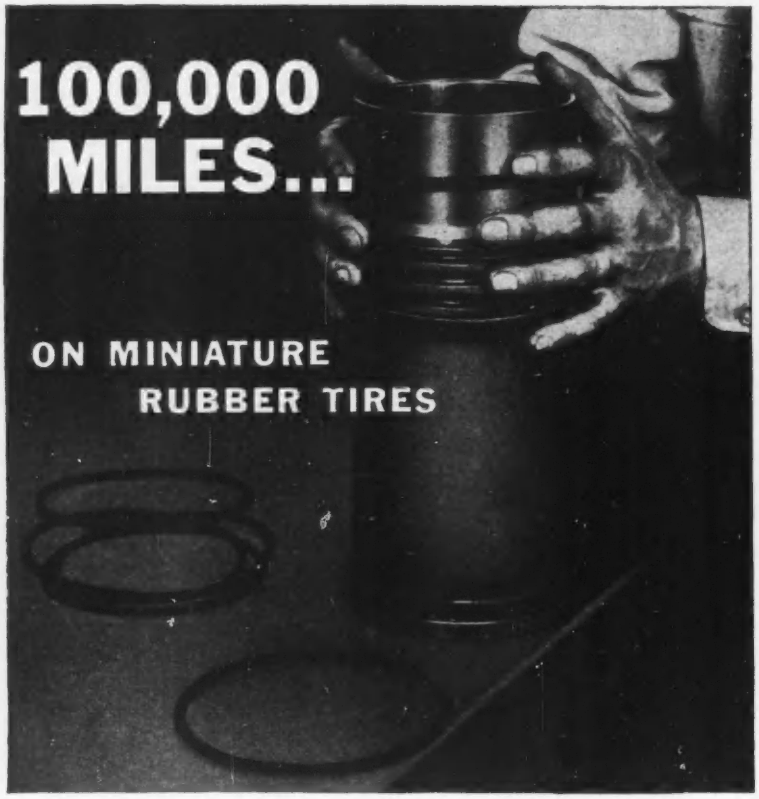
Please send me your 12-page illustrated booklet, "GLASS—its increasing importance in product design."

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____



Photograph courtesy of
Cummins Engine Company, Inc., Columbus, Indiana

Tire-shaped rubber packing rings for cylinder liners in Cummins diesel engines are small but important. They provide a seal between oil and water—a seal that must be perfect whether the engine is cold or operating at high temperatures. Moreover, these rubber rings must stand up for at least the equivalent of 100,000 miles of operation.

These severe operating requirements presented a rubber problem with exacting specifications: resistance to sustained heat—controlled swell in oil—exceptional compression quality—precision tolerances.

Continental met all these specifications and produced a rubber ring that gives outstanding service in an outstanding diesel engine.

The successful production of this specialized rubber part is typical of the complete service in rubber offered by Continental.

When *you* need molded or extruded rubber parts, why not enlist the assistance of Continental?

LET US SEND YOU THIS CATALOG

This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

See our Catalog in Sweet's File for Product Designers

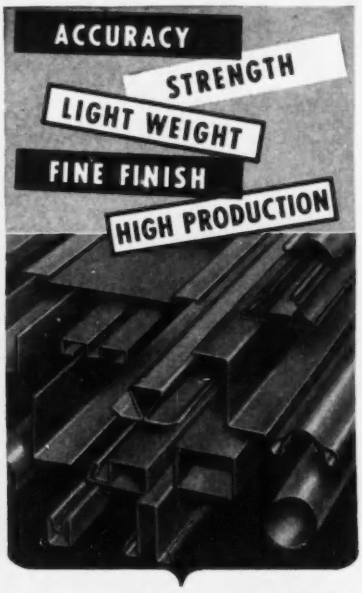
MANUFACTURERS SINCE 1903

CONTINENTAL
RUBBER WORKS

1982 LIBERTY STREET • ERIE 6, PENNSYLVANIA

BRANCHES

Baltimore, Md.	Cleveland, Ohio	Kansas City, Mo.	Pittsburgh, Pa.
Boston, Mass.	Dayton, Ohio	Los Angeles, Calif.	Rochester, N. Y.
Buffalo, N. Y.	Detroit, Mich.	Memphis, Tenn.	St. Louis, Mo.
Chicago, Ill.	Hartford, Conn.	New York, N. Y.	San Francisco, Calif.
Cincinnati, Ohio	Indianapolis, Ind.	Philadelphia, Pa.	Syracuse, N. Y.



COLD-ROLL-FORMING

gives you all of these advantages

At lower Cost—

● In busy metal working plants, vigilant production men are constantly on the lookout for places where, due to increased demand for their products, the time is ripe for a change of methods. They know that in the shaping of metals into finished products or components, cold roll forming has many important quality and cost advantages over all other methods.

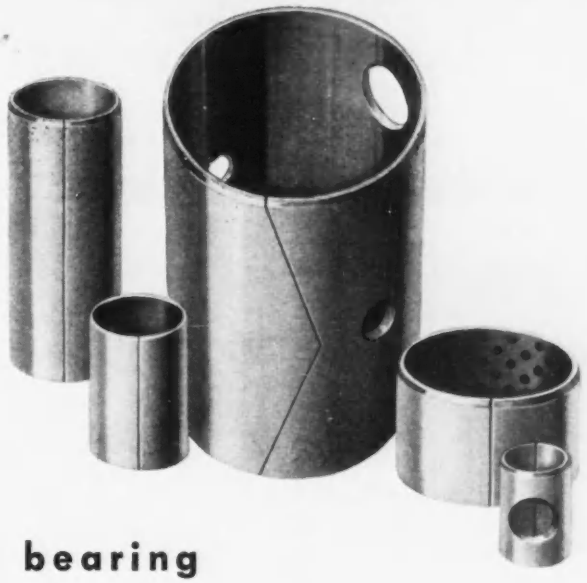
In some instances it becomes possible, by redesign of the product, to adopt cold roll forming. In others, the mere need for higher production makes the change profitable. Again, redesign often leads to a saving in weight which, in the case of the more expensive metals, alone may amount to much more than the conversion cost.

When such changes are indicated, feel free to avail yourself of the Yoder engineering service in analyzing and determining the practicability of cold roll forming, choice and cost of equipment, and other pertinent questions.

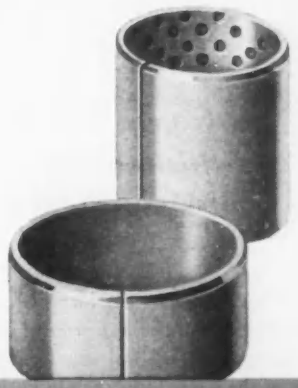
THE YODER COMPANY
5522 Walworth Ave., Cleveland 2, Ohio

Cold-Roll FORMING MACHINES

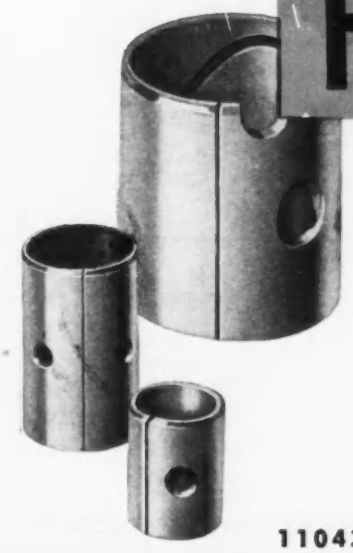
ENGINEERING YODER MANUFACTURING



You get bearing performance at rolled bushing costs with our Bimetal Bushings. Wide variety of diameters, lengths, lining alloys, on steel backs. Write today.



FEDERAL-MOGUL



Products of our six plants include: Sleeve bearings in all designs and sizes; cast bronze bushings; rolled split-type bushings; bimetal rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.

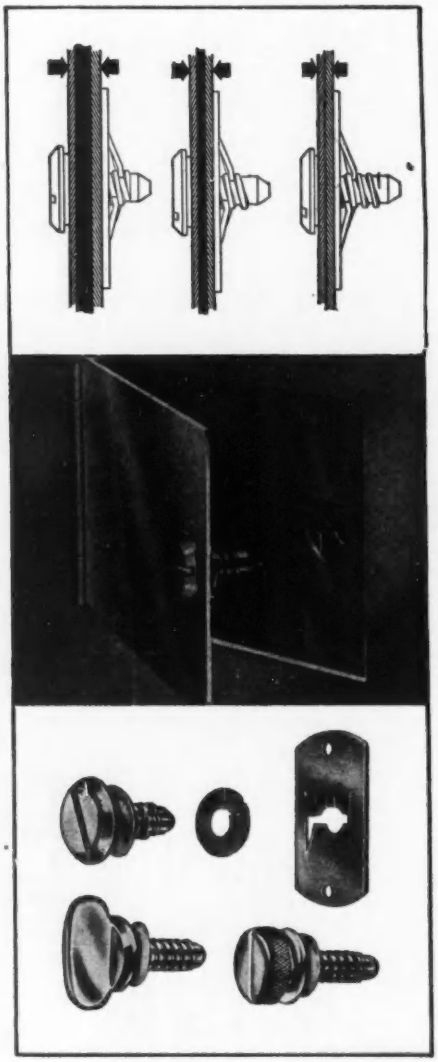
FEDERAL Mogul

SINCE 1899

FEDERAL-MOGUL CORPORATION

11043 SHOEMAKER • DETROIT 13, MICHIGAN

through thick or thin— *one fastener*



each grip length serves a wide range of thicknesses — to speed assembly and simplify stock requirements

In many ways, you save time and money with Southco Screw Fasteners. In countless applications, the wide grip range is but one of many advantages. Tension is always uniform, never too tight or too loose. A turn of the screw locks or unlocks, instantly. Installation is easy, without special equipment. Tapped holes are eliminated, along with screws, bolts, lock nuts, lock washers, etc. Alignment is not critical because fasteners "float" in the outer panel. Skilled help is not required. Even if access plates or doors or frames become warped, Southco Fasteners continue to perform, easily and efficiently, for the life of the assembly.

You get all these advantages and more, when you use Southco Fasteners. For complete information write Southco Div., South Chester Corp., 1406 Finance Bldg., Philadelphia 2, Pa.

Important for military contractors! Prompt deliveries now possible because of recently expanded plant facilities.

SOUTHCO®

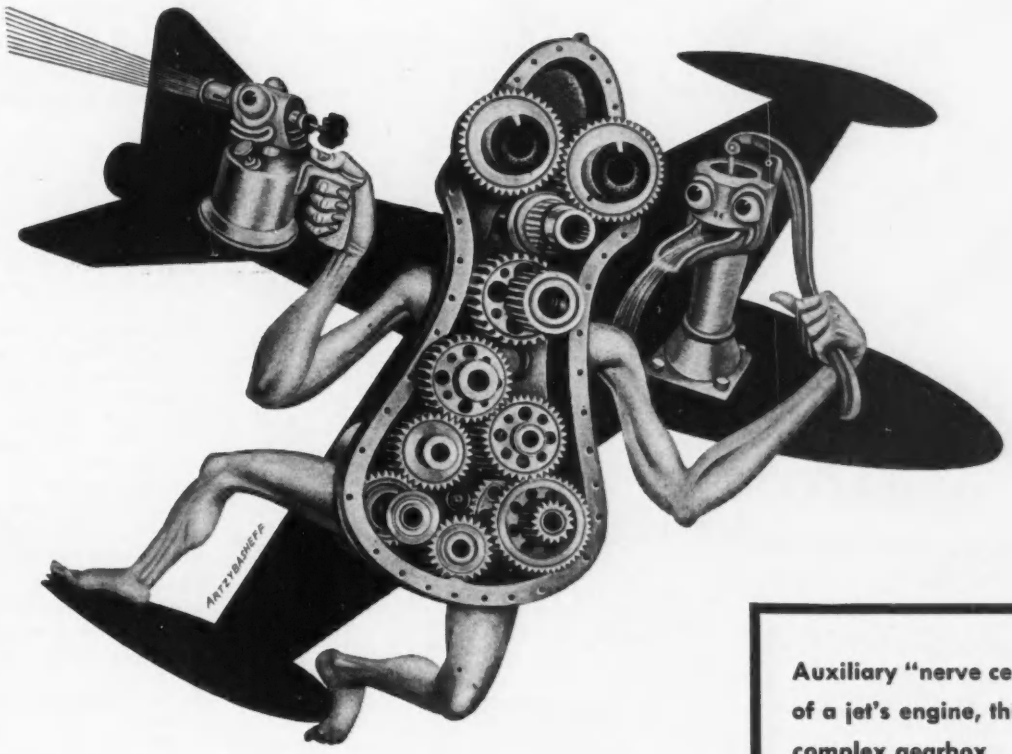
FASTENERS

PAWL · SCREW AND SPRING · DRIVE RIVETS · ANCHOR NUTS · ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

How a jet engine runs on its "nerves"



Auxiliary "nerve center" of a jet's engine, this complex gearbox transmits the power that runs oil and fuel pumps, generators, and other vital accessories. To produce this intricate unit for J-40 engines, Westinghouse looks to Lycoming for precision production.

From a jet's mighty engine, these precision gears "take off" power and pass it along to vital accessory equipment *at the specific rate required by each different* unit. As many as 30 separate gears . . . as many as 2500 separate machining and assembly operations . . . go into this gearbox so essential to safe, efficient operation of a jet. And for this tremendously complex production, Westinghouse depends on Lycoming.

Lycoming stands ready to assist *you*, too. Whether you have "just an idea" that needs development, a problem in the blueprint stage, or a finished metal product that needs precise, speedy fabrication . . . you can depend on Lycoming's long-tested ability to meet the most exacting and diverse industrial or military requirements. *Whatever* your problem—look to Lycoming!

Lycoming's 2½ million feet of floor space, its more than 6,000 machine tools, and its wealth of creative engineering ability stand ready to serve your needs.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

LOOK TO LYCOMING FOR RESEARCH FOR PRECISION PRODUCTION

LYCOMING-SPENCER DIVISION, WILLIAMSPORT, PA.
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.
AVCO MANUFACTURING CORPORATION

Lycoming-Spencer Division
AVCO Manufacturing Corp.
652 Oliver Street
Williamsport, Pa.

Please send me further information on Lycoming's varied abilities and facilities.

Name_____

Firm_____ Title_____

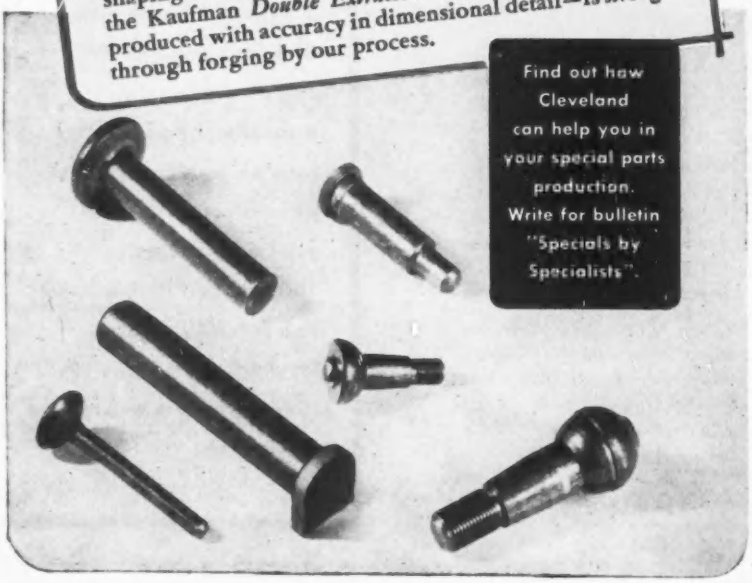
Address_____

City_____ Zone____ State____

Two profitable ways you can use Cleveland's Production Service for your Specially Designed Parts

Your non-standard parts can be manufactured *complete* (above) . . . or pre-formed by forging, ready for further shaping and machining in your plant (below). Made by the Kaufman *Double Extrusion* Process, your design is produced with accuracy in dimensional detail—is *stronger* through forging by our process.

Find out how Cleveland can help you in your special parts production. Write for bulletin "Specials by Specialists".



CLEVELAND *Top Quality* **FASTENERS**

THE CLEVELAND CAP SCREW COMPANY

originators of the Kaufman DOUBLE EXTRUSION Process

Specify

ADVANCE RELAYS

for precise circuitry

There are many reasons why Industry *specifies* ADVANCE RELAYS: They meet or surpass Military and Civilian requirements—many types have AN approval—many are hermetically sealed—*all* are lightweight—small—rugged—compact—and *all* are precision-built for efficient, trouble-free, long life performance.

If you have relay problems involving contact loads, coil resistances, close differential, timing features, input sources, critical environment or any particular requirements involving unusual or accurate circuit behavior, ADVANCE can supply the relay.

A complete line of relays for radar, radio, electronic and electrical equipment applications.

Write for new, descriptive Catalog containing detailed information about ADVANCE Relays and facilities.

ADVANCE ELECTRIC AND RELAY COMPANY

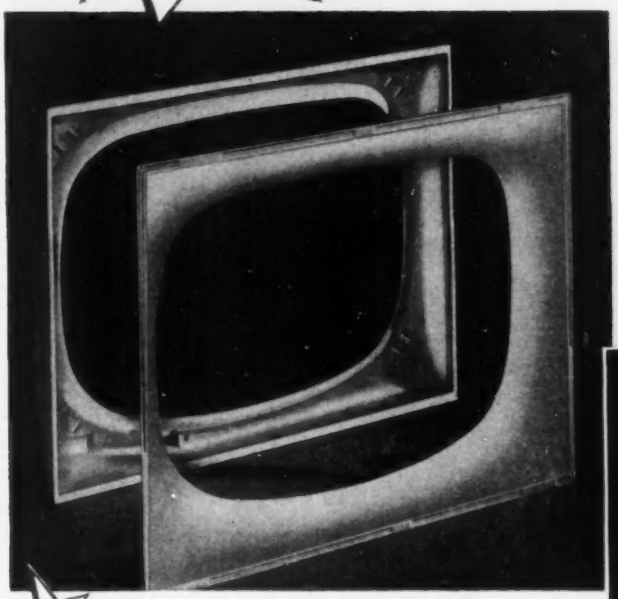
ADVANCE RELAYS

2435 NO. NAOMI ST., BURBANK, CALIF.

Sales Representatives in Principal Cities of U.S. and Canada

a new star in television...

Koppers Polystyrene!



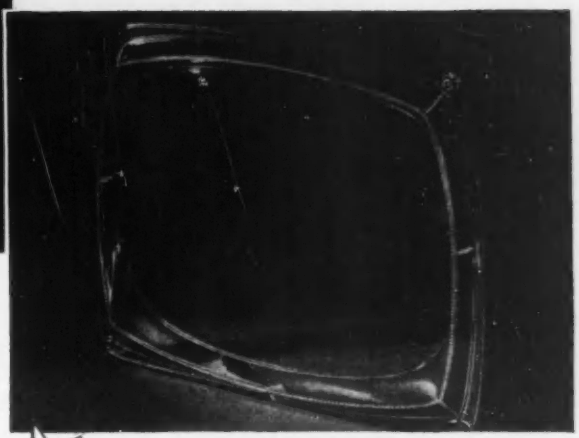
VERSATILITY and quality of performance, plus economy in production, explain the rising popularity of Koppers Polystyrene with the designers and manufacturers of television sets. Its performance in the applications shown here has been highly satisfactory and forecasts a larger and more important role in the production of television sets in the future.

There's a type of Koppers Polystyrene for practically every product need. A letter of inquiry will quickly bring a Koppers representative with details about the Koppers Polystyrene that best fits your particular needs.

Sylvania's HaloLight, a frame of light around the picture tube, incorporates Koppers "Evenglo" Polystyrene with which opacity, color and diffusion of light can be more accurately controlled than with any other material commonly used. Koppers formulation of "Evenglo" assures exact similarity of light characteristics in each piece, as well as the required stability and dielectric strength.

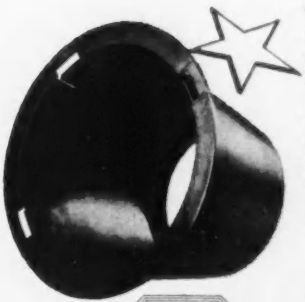
The mask used in Sylvania's HaloLight frame is Koppers Modified Polystyrene MC 305. Koppers Modified Polystyrenes combine high shock resistance and greater toughness with physical strength, smooth finish and the other desirable characteristics of regular polystyrene.

Molder: Amos Molded Plastics, Edinburg, Indiana.



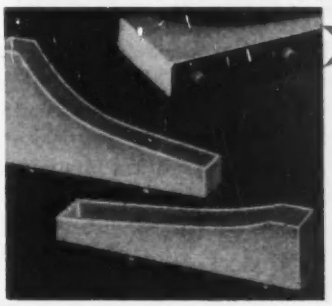
This front lens, made for Majestic Radio and Television, Division of the Wilcox-Gay Corp., is molded of Koppers crystal Polystyrene 31. Its combination of properties permits its use in a variety of large moldings. Crystal clarity, light weight and dimensional stability make it an economical material.

Molder: Prolon Plastics, Division of Prophylactic Brush Co., Florence, Mass.



This rear protective cap for the reverse end of the picture tube is made of Koppers Polystyrene MC 305, one of the Modified Polystyrenes with high resistance to shock and impact. It can be molded easily, quickly and economically to the close tolerances required in the finished product.

Molder: Sylvania Electric Products Inc., Warren, Pa.



These supports for a picture tube were molded for Zenith Radio Corporation. Ability to withstand the heat and weight of the tube were necessary requirements of the supports. Koppers Polystyrene satisfied these essentials at a low unit cost.

Molder: Service Plastics, Inc., Chicago, Ill.

Koppers Plastics Make Many Products Better and Many Better Products Possible

KOPPERS ®

Koppers Plastics

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-23, PITTSBURGH 19, PA.

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · CHICAGO · DETROIT · LOS ANGELES

Get More for your CHAIN Dollar . . .

Specify ACME Roller Chains

Today — machines are precision engineered to meet the demands for ever increasing output. That's why it's important to get maximum results from your chain drives. ACME Roller Chains best meet these demands. Their positive grip affords efficient power transmission . . . means you get full rated power. They reduce costly time — are easy to install. ACME Chains are ruggedly constructed of hardened steel to assure long service with minimum maintenance . . . vital to maximum production. Be sure to get more for your chain dollars by specifying ACME Chains.

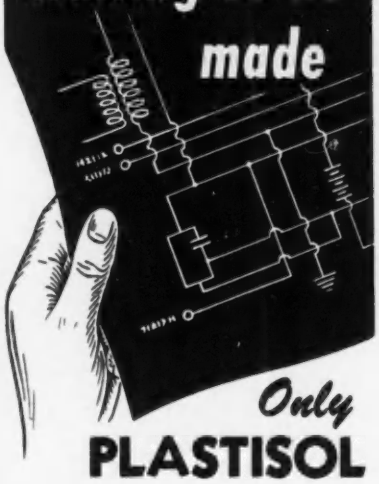
When you put ACME Roller Chains to work, you're putting to work more than thirty years' diversified experience in the roller chain industry. Let ACME engineers recommend a chain drive that will give you trouble-free operation, peak performance, high level production, plus low maintenance costs. We invite your chain problems which will receive prompt attention. Write or phone today.

Write Dept. 1D for new illustrated 76 page catalog on use and application of roller chains and sprockets.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

ELECTRICAL

For products waiting to be made



Only

PLASTISOL INSULATION

for Molding, Extruding or Dipping can be specifically compounded to produce these advantages:

- Ease of molding or coating — inexpensive molds or equipment required
- Good aging properties under normal operating temperatures
- Low temperature flexibility
- Good outdoor durability
- Resists most acids and alkalis
- Good flame resistance
- Resistance to oil and grease

Whatever you manufacture, from spaghetti wiring to circuit-breaker panels, Stanley chemists can formulate a vinyl plastisol to meet your most exacting insulation requirements. For specific information write *today* to the Stanley Chemical Co., 82 Berlin St., East Berlin, Conn.

STANLEY *Industrial Coatings*

STANLEY CHEMICAL

LACQUERS JAPANS SYNTHETICS ENAMELS

Now is the time to evaluate

TITANIUM

THE STRONG, LIGHT STRUCTURAL MATERIAL WITH OUTSTANDING CORROSION RESISTANCE

PRODUCTION QUANTITIES of titanium and titanium alloys are now available in fabricated and semi-fabricated forms for commercial evaluation. Made from titanium sponge, pioneered commercially by Du Pont, these new materials of construction possess very high strength to weight ratios...excellent corrosion resistance with greater ability to stand elevated temperatures than aluminum or magnesium. Together, these properties mean new design horizons for engineers and metallurgists . . . may mean that your product of tomorrow can be made better, faster and at lower cost.

IMPORTANT PROPERTIES

HIGH STRENGTH. Tensile strengths of 65,000 to 175,000 psi (with corresponding yield strengths of 55,000 to 160,000 psi and elongations of 25 to 10%), depending upon alloy and degree of cold work.

LIGHT IN WEIGHT. Density of 0.16 lbs./cu. in. 44% lighter than common structural steels.

EXCELLENT CORROSION RESISTANCE. Comparable to austenitic stainless steel in general properties. Remarkable in resistance to nitric acid, moist chlorine, chlorides, marine atmosphere and salt water.

GOOD FATIGUE STRENGTH. The only known structural metal with an endurance limit (stress and torsional) consistently in excess of 50% of tensile strength.

INTERMEDIATE TEMPERATURE OPERATION. Properties not substantially affected by prolonged operation in temperature range of 400° to 800°F.

FORMABILITY. Can be hot or cold rolled, forged, stamped, pressed, joggled, sawed, machined, etc., with equipment conventionally used for stainless steel.

WELDABILITY. Commercially pure grades can be readily spot and seam welded without inert gas protection. Flash and arc welding of these materials can be easily accomplished under inert gas cover.

AVAILABILITY. In sponge, billets, sheet, strip, rod, bar, wire and tubing as commercially pure titanium and in a wide range of titanium based alloys.

SUGGESTED APPLICATIONS

AIRCRAFT

- Cowling and Ducts
- Structural Parts
- Fire Walls
- Fastenings and Fittings
- Power Plant Components

MARINE

- Condensers and Heat Exchangers
- Mufflers
- Metering Equipment
- Trim and Hardware
- Valves and Pumps

CHEMICAL AND INDUSTRIAL

- Food Processing and Handling
- Refinery Equipment
- Chemical Processing
- Instrument Parts
- Textile Shuttles and Spindles

FERROUS & NON-FERROUS ALLOYS

- Grain Refiner
- Hardening Agent
- Carbon Stabilizer

for FURTHER INFORMATION

Although Du Pont is a prime producer of titanium metal in sponge form and not a manufacturer of fabricated shapes of titanium or titanium alloys, we will be happy to send you additional information on the properties, applications and processing of this new structural material. We will also be happy to give you advice on how you can obtain samples for commerical evaluation. Just mail the coupon below to: E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Wilmington 98, Delaware.

DU PONT
TITANIUM

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Pigments Dept., Wilmington 98, Delaware

Please send me more information about titanium and titanium based alloys: Properties, applications, processing, etc. I am interested in evaluating titanium for the following applications:_____

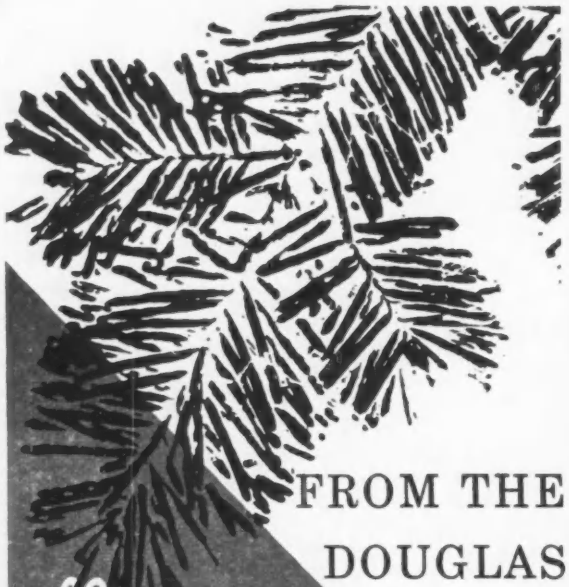
_____

*Name*_____ *Position*_____

*Firm*_____

*Street and No.*_____

*City*_____ *State*_____



FROM THE DOUGLAS FIR COUNTRY

allwood* the New hardboard

Amazingly tough, amazingly versatile...challenging comparison as a new leader in quality hardboard. Allwood is structurally sound, dimensionally stable, uniformly strong. Durable, dependable Allwood can be produced to answer your design problems, fit your plans or meet your manufacturing needs.

Simpson Logging Company of Seattle, Washington, are exclusive national sales agents for Allwood.

Send for FREE booklet
The Allwood Story

OREGON LUMBER COMPANY

BAKER, OREGON

Allwood can be bent, die cut, scored, drilled, laminated, shaped, routed, planed, sawed, nailed, glued and processed in almost any way you wish or the job demands.

UNSUNG HEROES

Deep down inside, close to the heart of things, intricate gearing mechanisms probably control the functioning of most machines. Gears are the unsung heroes of many a production success.

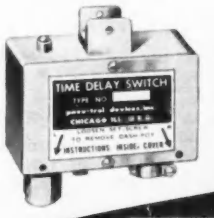
Diefendorf modestly accepts its role as designer and producer of gears to help make your products successful.

DIEFENDORF GEAR CORP.

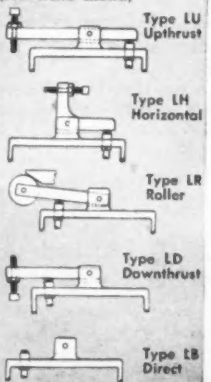
Syracuse, N. Y.

DIEFENDORF GEARS

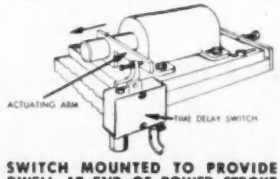
NEW CYLINDER TIME DELAY CONTROL SWITCH INCREASES APPLICATION . . . WIDENS USE OF CYLINDER POWER



For Any Type Actuation Left or Right Hand (Left Hand Shown)



Pneu-Trol Time Delay Switches provide independent hydraulically controlled adjustable time dwell between ¼ and 60 seconds in 20 to 1 ratios. Readily mounted on machine for cylinder dwell at a positive stop. Compactly designed—a simplified low cost answer to electrical time dwell control of any air or hydraulically operated machine movement such as press work, burnishing, coating, quenching, metal-cutting, etc. Ideal for automatic feeders. Dimensions: 4⅛" wide; 2⅜" high; 1-7/16" deep. Overall height 4⅛".



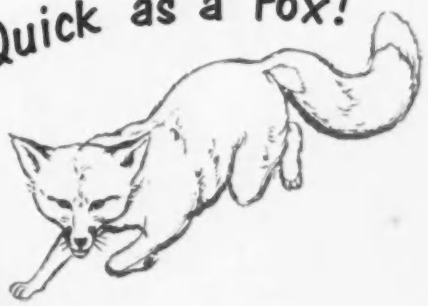
SWITCH MOUNTED TO PROVIDE DWELL AT END OF POWER STROKE

Write for descriptive literature and complete details.

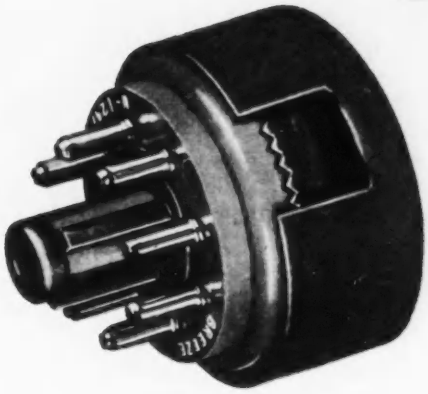
PNEU-TROL DEVICES, INC.
1430 N. Keating Ave. Chicago 51, Illinois

RUGGED as a RHINO . . .

Quick as a Fox!



Two Special Purpose Connectors by BREEZE MARK

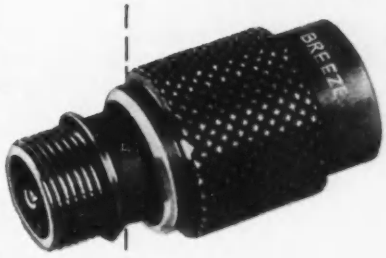


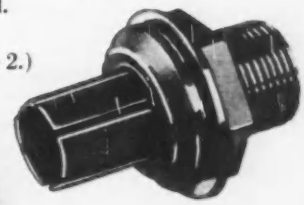
Battery Connectors

8-pin type for both A and B batteries used in all types of field communication equipment. "RUGGEDIZED" for extra security and long service life: polarizing stud is ALL METAL and all metal parts are cadmium plated and sealed with an iridite sealer. Cable may be brought out at any desired side position and locked. Handy bail makes removal from inaccessible places easy.

Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP – 416, Type 2.)

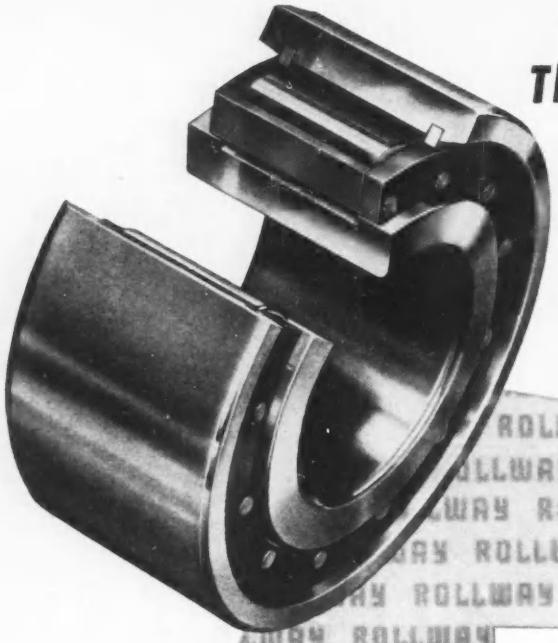




Receptacle Types: Round flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

We invite your inquiries on any problems concerning connectors. Our wealth of engineering experience in this specialty is at your service.

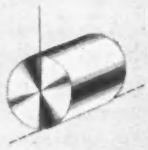
BREEZE
CORPORATIONS, INC.
41 South Sixth Street, Newark, N. J.



There's a growing preference for ROLLWAY BEARINGS ...and with good reason!

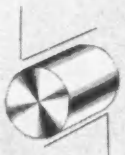
RIGHT ANGLE

ROLLER ENDS, precisely square to avoid end-rub, oscillation and side-shock.



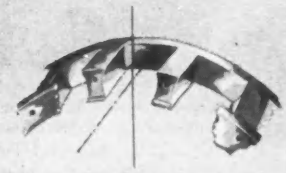
RIGHT ANGLE

BEARING SURFACES with parallelism that results in unwavering right-line rolling.



RIGHT ANGLE

SEPARATOR SLOTS accurately machined to prevent roller skew, slide and uneven wear.



Unwavering right-line rotation—free of skew, side-shock and end-rub—greatly extends the life expectancy of a Rollway Roller Bearing. Add to longer life the definite gains in smoother operation and lower maintenance costs and it's understandable why, today, demand for Rollways has reached a new peak.

Our increased facilities are expanding Rollway output as fast as possible. We are continuing to improve the balance between supply and demand, so that service to both established and new customers will be geared to their quantity requirements . . . another reason why bearing users can confidently specify "The bearings that *roll* right because they're *made* right."

Let's examine your bearing problems together. Our years of specialized experience, plus complete metallurgical services, are at your command. Just write or wire Rollway Bearing Co., Inc., Syracuse 4, N. Y.

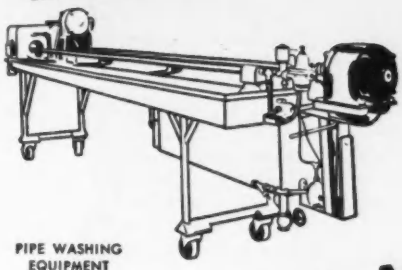
SALES OFFICES

Syracuse	Chicago
Cleveland	Pittsburgh
Houston	Detroit
Boston	Los Angeles
Philadelphia	Toronto

ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

WHAT are your Valve Needs?



PIPE WASHING EQUIPMENT

CASH-ACME HAS THE Answer!

AIR VISE

Rising costs—delivery—are they affecting the quality of your finished product? If pressure control is a vital part of its operation, make sure the valve selected is a CASH-ACME. If you do not find the specified valve required, let CASH-ACME's staff of engineers study your problem and make their recommendation. There is no obligation.

Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.

SEPARATOR PARTS WASHER FOR DAIRY

CONCRETE MIXER

CASH ACME

SILENT SENTINEL *Automatic Valves*

A. W. CASH VALVE MFG. CORP.
6662 E. Wabash Avenue • Decatur, Illinois

ATTACH TO YOUR LETTERHEAD

A. W. Cash Valve Manufacturing Corp.,
6662 E. Wabash Avenue
Decatur, Illinois

☐ Please send me your free booklet.

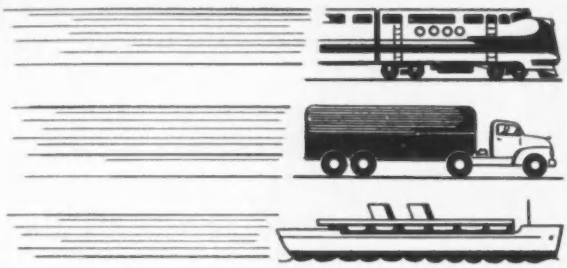
NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

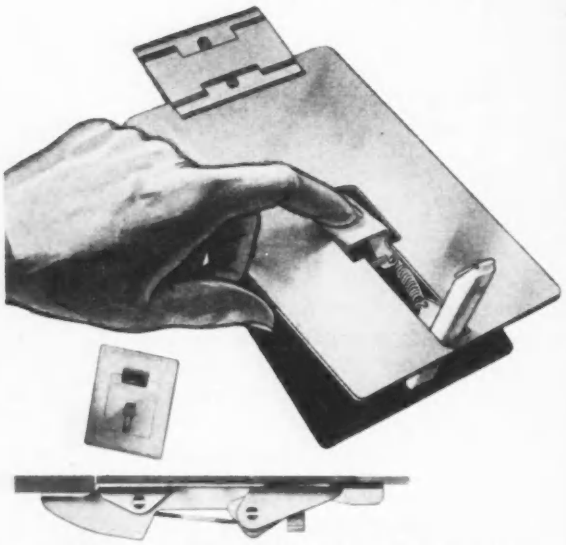
To save time may we suggest a brief outline of your requirements be mailed with this coupon.



HARTWELL

Trigger-Action

FLUSH LATCHES AND HINGES



The World's best and most complete line for every application . . .

"Make them *flush, safe* and *simple!*" was the plea of industries to the latch and hinge manufacturers.

So HARTWELL did. *Flushness* for streamlining, efficiency and economy. *Safe*, rugged,compactness for dependable performance. *Simple*, positive-action to speed up maintenance operation.

Finger-tip pressure on the trigger of the latch releases the bolt and permits the door to open. Finger-tip pressure on the bolt, when the door is in place, locks it shut.

Dynamically *flush* and *safe*, they meet or surpass the most exacting requirements.

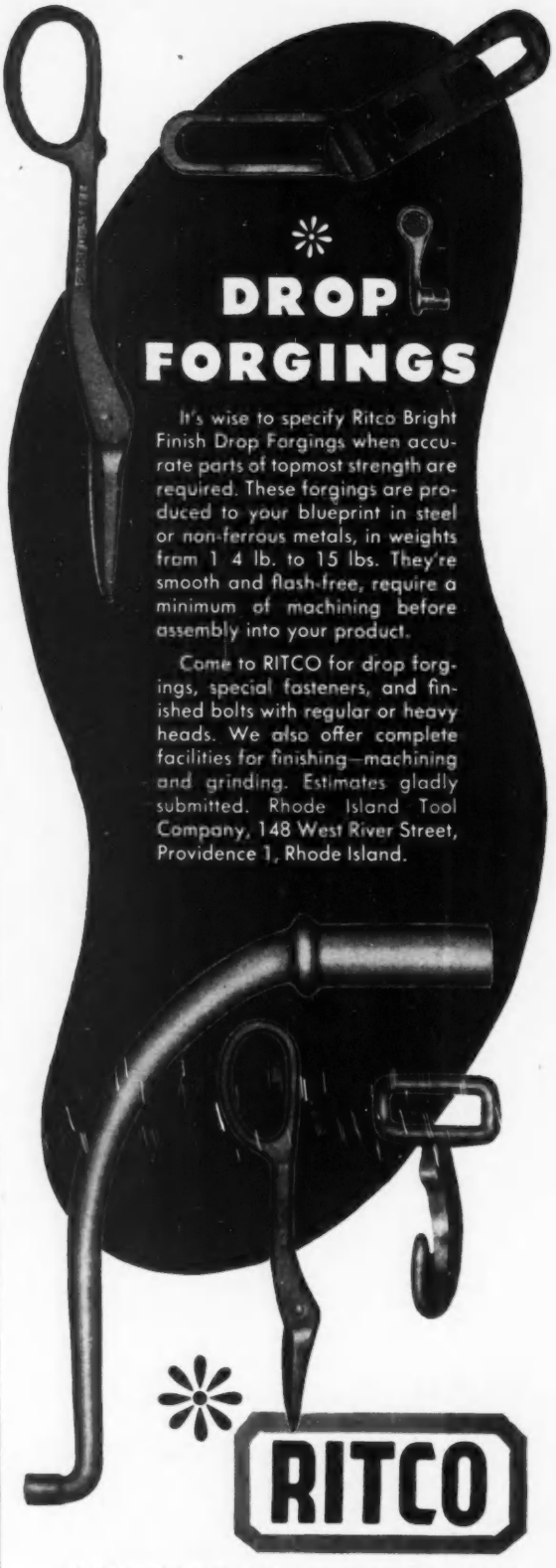
Write for engineering specifications and counsel.

HARTWELL

COMPANY

Manufacturers of Flush Latches and Hinges, Fittings and Cable Terminals.

9035 Venice Blvd., Los Angeles 34, Calif.



DROP FORGINGS

It's wise to specify Ritco Bright Finish Drop Forgings when accurate parts of topmost strength are required. These forgings are produced to your blueprint in steel or non-ferrous metals, in weights from 1 4 lb. to 15 lbs. They're smooth and flash-free, require a minimum of machining before assembly into your product.

Come to RITCO for drop forgings, special fasteners, and finished bolts with regular or heavy heads. We also offer complete facilities for finishing—machining and grinding. Estimates gladly submitted. Rhode Island Tool Company, 148 West River Street, Providence 1, Rhode Island.

RITCO

EXCLUSIVE NEW ENGLAND REPRESENTATIVES FOR CLEVELAND CAP SCREWS

★ SERVING AMERICAN INDUSTRY SINCE 1834 ★

Don't Let Copper Restrictions Stump You

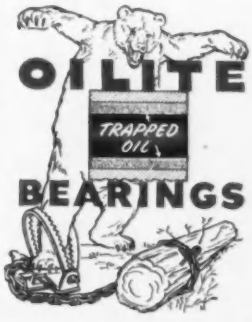
IRON BASE

OILITE

GIVES YOU TOP BEARING PERFORMANCE

- Iron Oilite is an excellent heavy duty bearing material.
- It is a sturdy material, and the load carrying capacity is increased by the hydraulic cushion of the trapped oil with which the bearing metal is impregnated.
- Iron Oilite bearings provide the acme in lubrication; a continuous, unbroken, oil film, on the bearing surfaces.
- Iron Oilite is available in all types of bearings and over a broad range of sizes.
- Iron Oilite is only one of the famous Oilite family of products created by Oilite powder metallurgy.

AMPLEX MANUFACTURING COMPANY
Subsidiary of Chrysler Corporation
Detroit 31, Michigan



FIELD ENGINEERS AND DEPOTS THROUGHOUT UNITED STATES AND CANADA

Oilite Products include:
BEARINGS, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units in both ***NON-FERROUS*** *and* ***FERROUS*** *Metals*

COPYRIGHT 1952 — THE CHRYSLER CORP.

NICE Announces New Lines!

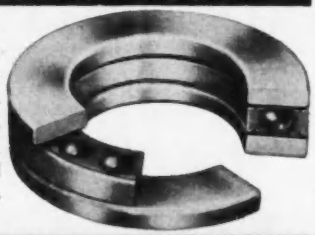
PRODUCT DESIGNERS will be interested in these new "cost saving" additions to the NICE Line. FOR COMPLETE INFORMATION WRITE FOR CATALOG NO. 150.

"C" SERIES GROUND RADIAL BEARINGS
SOLID RACE TYPE WITH BALL RETAINER

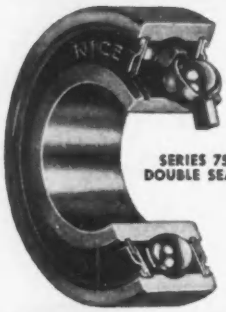
The new NICE "C" series are precision radial bearings made in inch dimensions which correspond to established light duty inch standard sizes. Produced with ground and polished race ways and assembled with chrome alloy balls, they are designed for light duty radial, thrust or combined load applications and speeds in the neighborhood of 5000 R.P.M. maximum. "C" series radials are available without shields, single shielded or double shielded.

"FR" SERIES GROUND THRUST BEARINGS
FLAT BALL RACES WITH BALL RETAINER

"FR" series flat race thrust bearings conform to established inch standard sizes and are recommended for light loads and speeds up to 2500 R.P.M. The ball cages are made from solid brass stock for durability and long life and the ball track surfaces are precision ground to a high finish.



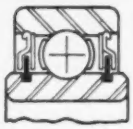
7500 AND 7600 SERIES GROUND RADIAL BEARINGS
SOLID RACE TYPE WITH BALL RETAINER-LABYRINTH COMPOSITION SEALED



SERIES 7500 DOUBLE SEALED

SERIES 7600 DOUBLE SEALED

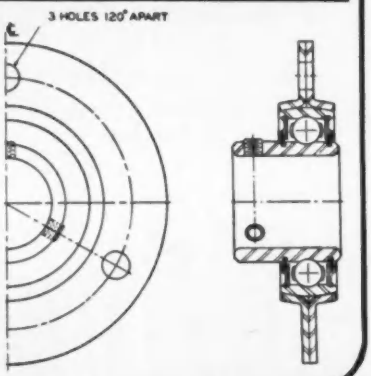
Series 7500 and 7600 bearings are recommended for applications requiring the accuracy of rotation and quiet performance of close limit precision bearings, and where a highly efficient seal is required to retain lubricant and exclude foreign materials. They are designed for medium loads and speeds in the neighborhood of 5000 R.P.M. maximum, and are made in inch standard sizes. Normally double sealed, series 7500 and 7600 bearings can be produced to order with seals on one side only or without seals.



SEAL DETAIL
An oil resistant synthetic rubber coated fabric ring fits into a groove in the inner race and the recess formed by the inner and outer dust caps.

FLANGE MOUNTED SELF-ALIGNING RADIAL BEARINGS
LABYRINTH COMPOSITION SEALED-TWO LOCKING SET SCREWS

NICE series F100 flange mounted radial bearings are designed for easy application to machine frames. The self-aligning feature together with their highly efficient labyrinth composition seal (see detail above), makes them ideal for a wide variety of applications such as farm machinery, conveyors, power transmissions, blower and fan installations. They are available in popular inch shaft sizes and are recommended for medium load and speed service conditions.



NICE

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA

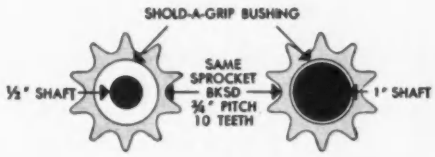
Here's what you've wanted . . .

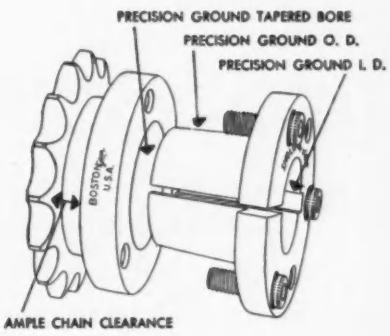
in interchangeable sprocket assemblies

- Better Design
- Broader Size Range
- Slip-Proof Grip
- BOSTON Gear Quality

The New SHOLD-A-GRIP®

INTERCHANGEABLE TAPERED BUSHINGS





Accomodates MORE Sprocket Sizes

In the SHOLD-A-GRIP Sprocket, holes for fastening set screws are in the shoulder. Thus, no metal is cut from the sprocket itself. This assures maximum strength, and permits cutting a minimum number of teeth with a maximum size bore. SHOLD-A-GRIP Sprocket Pinions can be fitted to a wider range of shaft sizes — from ½" to 2½" — easily and quickly with SHOLD-A-GRIP Bushings.

Permits Use of SMALLER Sprocket Pinions

The unique shoulder construction brings smaller sprockets into the interchangeable class. For example, Sprocket BKSD ¾" Pitch with 10 teeth can be used on any size shaft from ½" to 1" by inserting the correct size SHOLD-A-GRIP Bushing.

Gripping Power Exceeds Chain Strength

PRECISION-GRINDING of tapered bore of SHOLD-A-GRIP Sprocket, and of inside and outside diameters of SHOLD-A-GRIP Bushing assures:

1 Equalized gripping power the entire length of bushing (even if shaft is not to size).

2 Maximum gripping power. Tests show CHAIN WILL BREAK before SHOLD-A-GRIP will SLIP.

Look over the SHOLD-A-GRIP, and see why it is your best buy. Get complete details...ask your BOSTON Gear Distributor, or write for the new SHOLD-A-GRIP folder. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

BOSTON Gear

POWER TRANSMISSION PRODUCTS

OVER 3000 STOCK ITEMS

OFF-THE-SHELF DELIVERY FROM STOCK AT YOUR NEARBY BOSTON GEAR DISTRIBUTOR

"a big job well done..."*

Here is an excerpt from one of the hundreds of letters *Product Engineering* subscribers have written to tell us how much the ANNUAL HANDBOOK OF PRODUCT DESIGN FOR 1953 is helping them:

*"Our HANDBOOK arrived yesterday, and in looking through it, I found sources for information for which I had been searching for several days. I would like to thank you for a big job well done."

Chief Tool Engineer
Aircraft Manufacturer

Miller

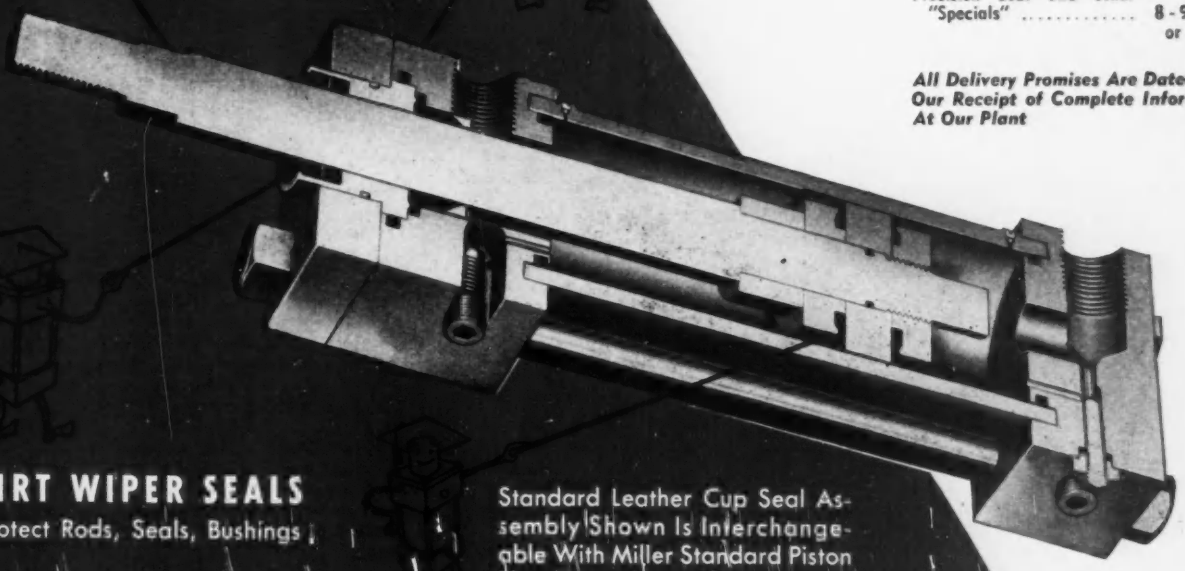
HIGH PRESSURE HYDRAULIC CYLINDERS

HARD CHROME PLATED PISTON RODS

Prevent Scratch-Damage, Nicks and Rust

SOLID STEEL HEADS, CAPS and MOUNTINGS

Eliminate Breakage



DELIVERY

Our normal delivery is now 8 to 10 weeks or longer whenever possible. However, we can make occasional deliveries to meet your RUSH cylinder requirements as follows:

Standard Models except as noted below	4 - 5 weeks
Models 81 and 82	6 - 7 weeks
Water-Fitted Models	7 - 8 weeks
Precision Seal and other "Specials"	8 - 9 weeks or longer

All Delivery Promises Are Dated From Our Receipt of Complete Information At Our Plant

DIRT WIPER SEALS

Protect Rods, Seals, Bushings

Standard Leather Cup Seal Assembly Shown Is Interchangeable With Miller Standard Piston Ring Piston Assembly

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. HYDRAULIC STANDARDS years before their adoption in 1949.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER MOTOR COMPANY

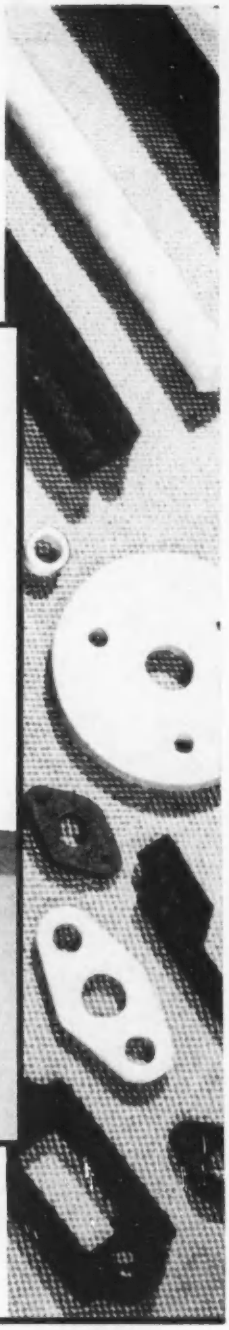
2002-04 N. HAWTHORNE AVE., MELROSE PARK, ILL.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

SOFT enough to be rolled into a ball, or hard enough to be ground and chiseled. Felters Felt is used for jobs like padding delicate instruments and polishing glass.

FELT
by FELTERS

— JUST THE WAY YOU NEED IT, IN ANY SHAPE, THICKNESS, COLOR OR CONSISTENCY.



SOME OF MANY JOBS YOU CAN DO WITH FELT BY FELTERS

SEALING oil in and keeping dirt out are jobs that Felters Felt is doing for manufacturers who use oil seals, gaskets, window liners, etc.

VIBRATION isolation is one of the biggest uses for Felters Felt. Various grades are available to reduce transmitted vibration as much as 85%.

CUTTING of Felters Felt is easy. Die-cutting, sciving, grinding, etc. are done quickly, without frayed edges. Or, we will cut parts to meet your specifications.

Dozens of ideas and technical data about Felt are given in this 16-page "Felters Design Book". To make the best use of the exclusive combination of properties Felt provides, write for your copy of the "Felters Design Book".

The **FELTERS** Company
228 South Street, Boston 11, Mass.

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

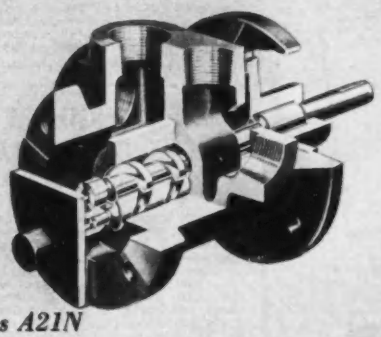
AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" — "they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

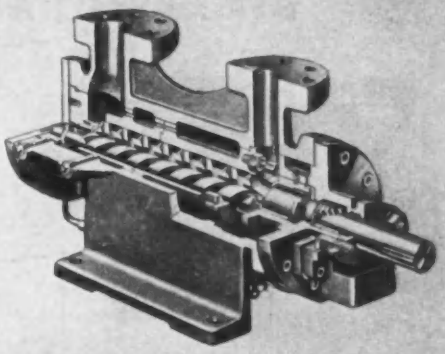
McGRAW-HILL PUBLICATIONS

DE LAVAL *can solve your design problems*

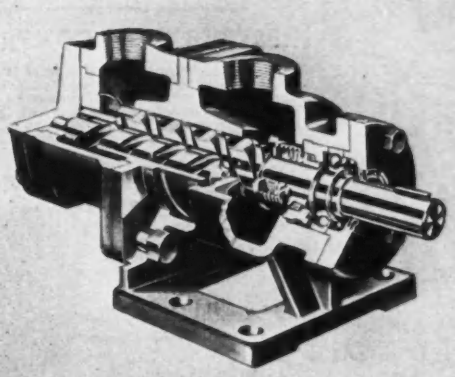
IMO PUMPS



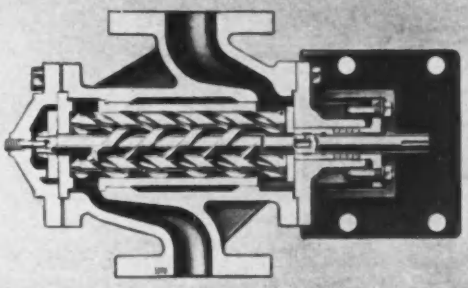
1. *Series A21N*



2. *Series A31H*



3. *Series A313A & B*



4. *Series A314A*

Designed to solve a wide range of pumping problems, De Laval IMO rotary pumps offer many important advantages. The unique IMO design—with only three moving parts—assures long, trouble-free performance. IMO pumps are quiet, pulsation-free, compact and designed for direct-connected high-speed operation.

1. *Series A21N* are widely used for lubrication and hydraulic services. Available for capacities to 10 gpm and pressures to 100 psig. *Send for Catalog L21NA for base plate mounting and Catalog L21NT for integral mounting.*

2. *Series A31H* handle high pressure hydraulic and industrial fuel oil burning applications. Available for capacities to 150 gpm, continuous pressures to 1,000 psig and intermittent pressures to 1,500 psig. *Send for Catalog L31H.*

3. *Series A313A & B* are designed for general oil handling, lubrication, oil transfer, fuel oil burner, hydraulic systems, elevator and similar service. Available for capacities to 80 gpm. A313A handles pressures to 150 psig; A313B from 150 to 275 psig. *Send for Catalog LS.*

4. *Series A314A* are suitable for fuel oil burner service, lard, shortening, vegetable oils, hydraulic systems, booster and circulating systems, pressure lubricating, elevator and similar applications. Available for capacities to 30 gpm and pressures to 500 psig. *Send for Catalog LS.*

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

601 Nottingham Way, Trenton 2, New Jersey

DL 165

Qualified

DIMENSIONALLY...

To further assure duplicate exactness *Unitcast* will accept or design for you *qualifying gauges* incorporating machine fixture locators to points given by your tool engineers.

PERUSE THESE FACTORS...

1 Do your machining and assembly time allowances fluctuate out of allowable control limits due to casting variances?

2 Could you eliminate costly machine operations if your cast parts were held to mutually accepted tolerance limits?

3 Would the elimination of just one machine operation facilitate a greater overall production flow in the line set-up?

Are these factors a problem to you? If so, may we at *Unitcast* urge you to call upon our sales engineers and technical staff who are constantly transforming these problem questions into answered realities.

UNITCAST
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends.
Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. In Canada: Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS are *FOUNDRY ENGINEERED*

OIL HYDRAULIC POWER AND ITS INDUSTRIAL APPLICATIONS

You'll find this guide a valuable working tool covering modern practices in oil hydraulics—development, theory, and practical applications. Discusses generation of oil hydraulic power . . . its use in rotary and reciprocating motors . . . its control by suitable valves . . . its transmission through piping, tubing and fittings. **By W. Ernst, Hydraulic Consulting Engineer. 366 pp., 275 illus., $7.00**

ENGINEERING ORGANIZATION AND METHODS

Presents a specific plan for organizing and operating product-design engineering departments. Methods described are basic—proved by successful use in a variety of industrial concerns. Gives an insight into the fundamentals of organizing, operating, and controlling an engineering department, plus detailed instructions for applying these fundamentals. **By James E. Thompson, Consulting Mgmt. Engr. 337 pp., 147 illus., $5.00**

PRODUCTION CONTROL

Brings you the principles behind the improved controls systems which developed out of post-war industrial expansion. Hundreds of techniques—scores of actual industrial cases—show you how a carefully planned controls system can build up your volume. Covers operation analysis, budgeting costs, preparing a master schedule, translating orders into production, following up, inspection, record keeping, and many other planning and control methods. **By L. L. Bethel, W. L. Tann, F. S. Atwater, and E. E. Bung. 2nd Edition, 284 pp., 85 illus., $4.00**

GRAPHIC AIDS IN ENGINEERING COMPUTATION

Covers graphical and mechanical methods of computation. Treats the standard slide rules—the derivation of empirical equations from engineering data — the construction of nomographs by geometric methods and with determinants—the construction of special slide rules—and movable scale charts. Includes recent developments in nomography. **By Randolph P. Hoelscher, Head, Dept. of Gen. Engin. Drawing, U. of Ill., Joseph N. Arnold, Assoc. Prof. of Gen. Engin., Purdue U., and Stanley H. Pierce, Asst. Dean, Coll. of Engin., U. of Ill. 197 pp., 115 illus., $4.50**

SEE THESE BOOKS 10 DAYS FREE

McGRAW-HILL BOOK COMPANY, INC.
330 W. 42nd Street, NYC (36)

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus a few cents for delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon—same return privilege.)

- ☐ Ernst—OIL HYDRAULIC POWER—$7.00
- ☐ Thompson—ENGR. ORGAN. & METHODS—$5.00
- ☐ Bethel—PRODUCTION CONTROL—$4.00
- ☐ Hoelscher—GRAPHIC AIDS—$4.50

(Print)
Name .....
Address .....
City ..... Zone..... State.....
Company .....
Position PE-2

This offer applies to U. S. only.

Make Your Own Hose Lines

AEROQUIP HOSE AND FITTINGS ARE MATCHED FOR GUARANTEED PERFORMANCE

● No skill or special training is required to assemble Aeroquip Flexible Hose Lines by hand *in a matter of minutes!* YOU CUT COSTS because Aeroquip fittings are detachable and may be used again and again. YOU REDUCE INVENTORY because with Aeroquip bulk hose and a few fittings you can fill practically all your hose line requirements. YOU REDUCE DOWNTIME because with Aeroquip on hand, quick hose line replacements are available at all times.

Cut hose to length with hacksaw; screw into socket.

Oil nipple and inside of hose liberally.

Screw nipple into socket and hose.

Install fitting on other end; hose line is ready for use.

Aeroquip

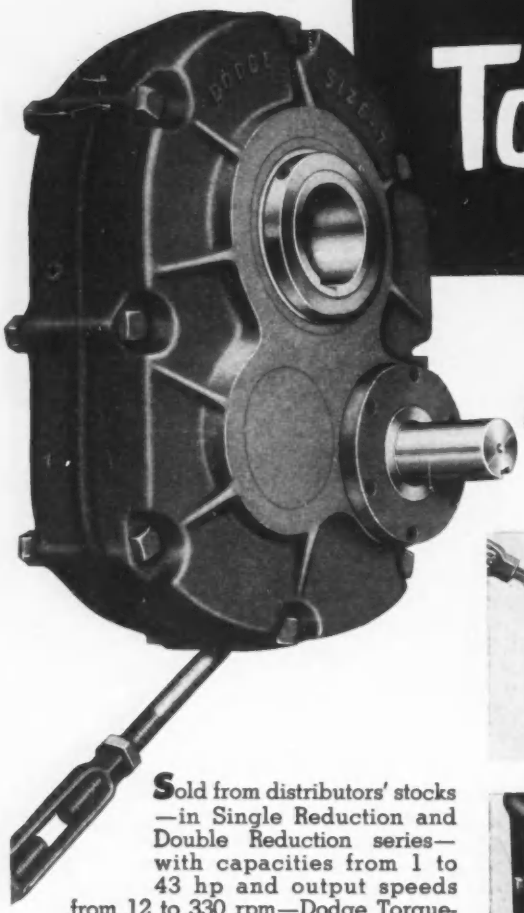
REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA.
MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

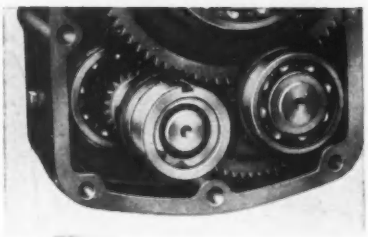
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Torque-Arm



The Most Complete Line of Shaft-Mounted Speed Reducers!

TRI-MATIC OVERLOAD RELEASE
Provides instant, positive protection for driven machines, motors and reducer itself. Automatically (1) loosens the belts, (2) cuts off power, (3) gives a warning.



TORQUE-ARM BACK STOP
Available from stock when required. Easily installed—sealed inside reducer housing. Simple, positive action prevents reversal.

Sold from distributors' stocks—in Single Reduction and Double Reduction series—with capacities from 1 to 43 hp and output speeds from 12 to 330 rpm—Dodge Torque-Arm is the new and modern idea in speed reducers.

No special engineering required. No foundation to provide. No flexible couplings. No sliding base. No lining up difficulties. No expensive installation. Stock Taper-Lock sheaves prescribed for each job to provide desired speeds. Application to other machines is practical and easy.

Unit is driven through any V-Belt Drive. Torque-Arm, fastened to any fixed object, anchors the reducer unit. Turnbuckle provides fast and accurate adjustment of belt tension.

Standardize on Torque-Arm, the speed reducer that saves you money.

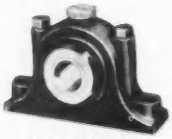
DODGE MANUFACTURING CORPORATION
1200 UNION STREET, MISHAWAKA, INDIANA

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory-trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone book.

1878 DODGE 1953 75th ANNIVERSARY

TAPER-LOCK SHEAVES, SEALED LIFE V-BELTS

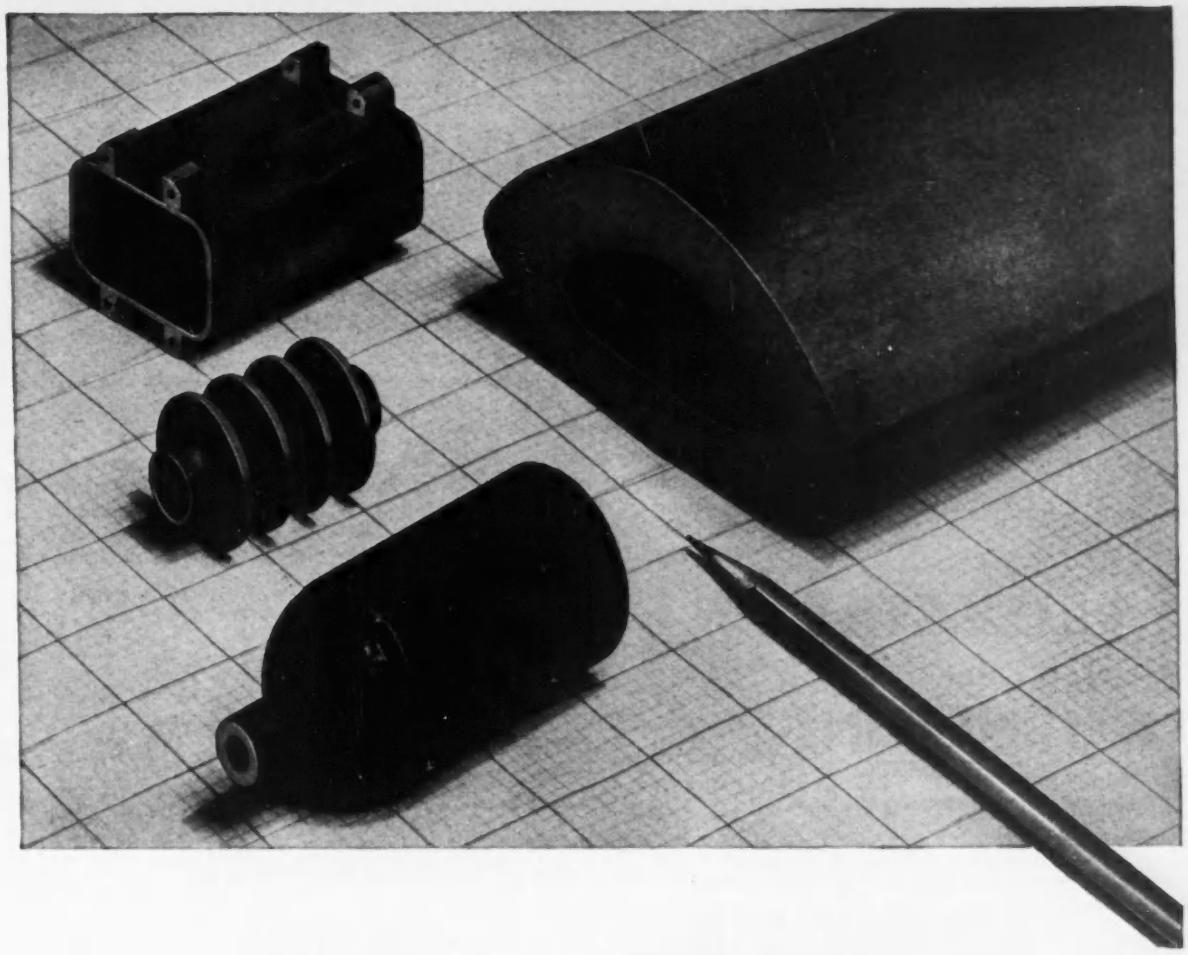


DODGE-TIMKEN PILLOW BLOCKS

TAPER-LOCK FLEXIBLE COUPLINGS

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 N. SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS



LET CARBONEERING BY SPEER help you with new solutions to your parts problems

Stumped by materials shortages?

Try *carboneering*—the development of carbon or graphite parts and designs for your application. Speer engineers have made carbon perform many new and interesting tasks for many industries.

For example—this special electrode Speer developed for use in milk pasteurizing equipment. With a weight of 15 pounds and a length of 25 inches, this electrode of impervious graphite has the high heat transfer and low electrical resistance necessary for low-cost, controlled heating of large volumes of fluid milk.

And, in contrast, the lightweight graphite anodes used in various types of electronic tubes have many advantages over materials they have replaced. They do not warp under high loads, they have superior heat radiation and they are nonmagnetic—a vital consideration in the design and manufacture of cathode ray tubes for television.

These are only two examples from two industries of the many parts and applications *carboneered* by Speer. If you have a design problem—or if shortages of critical materials are interfering with production—let Speer help you *carboneer* a practical solution. Send us full details.

You be the judge of carbon's versatility

Carbon can be:	Carbon has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	High heat transfer (graphite)
Planed	Carbon is:
Hobbed	Not wetted by molten metals
Ground	Non-warping
Molded	Chemically inert
Extruded	Self-lubricating (graphite)

SPEER Carbon Co.

St. Marys, Pa.

Divisions:

Speer Resistor • Jeffers Electronics

International Graphite & Electrode

A Step in the Right Direction

There's no "mark time" about these British-made

PECO DIE-CASTING MACHINES.

Indeed, with their characteristic new features, they're way ahead! They've a wonderful appetite for molten metal and, the digestive process—as it were!—being perfect, there's a wonderful discharge, at speed, of castings large or small, simple or intricate.

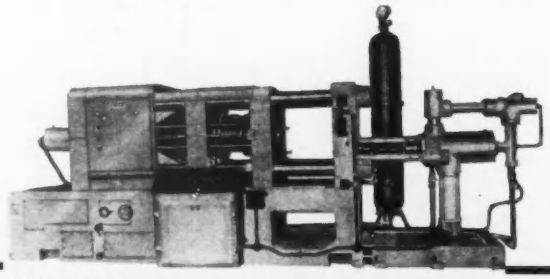
The model 10c Die-Casting Machine (as illustrated) is self-contained, hydraulically operated, suitable for hand or semi-automatic operation. The machine is also fitted with hydraulic ejection and provision is made for automatic interlocking core-pulling. The electrical control covers every movement of the cycle ensuring continuity and uniformity of production.

Illustrated literature on the 2c, 5c and 10c Die-Casting Machines sent on request.

PECO PRODUCTS

The PROJECTILE and ENGINEERING COMPANY LIMITED

ACRE STREET, BATTERSEA, LONDON, S.W.8
ENGLAND
Telephone: Macaulay 1212.
Telegrams: "PROFECTUS, CLAPROAD, LONDON"
Cables: PROFECTUS LONDON.



ARE YOU SWAMPED— Trying to Catch Up On Your Technical Reading?

Save up to 80% of your reading time covering new developments in technology: electronics — metals — plastics — chemistry — engineering — textiles — aviation — building — ceramics — foods — fuels and lubricants — health — nucleonics etc.

Keep up to date with TECHNICAL SURVEY, the only weekly report in the world devoted exclusively to progress in all branches of technology. Each news item gives complete reference for source reading. Monthly indices also available.

TECHNICAL SURVEY

367 BROAD STREET NEWARK 4, NEW JERSEY

Send for your free copy of Technical Survey

Please send free copy of Technical Survey, without obligation:

NAME .....

ADDRESS .....

Solenoid Valve Problem?

A Standard Skinner may fill the bill!

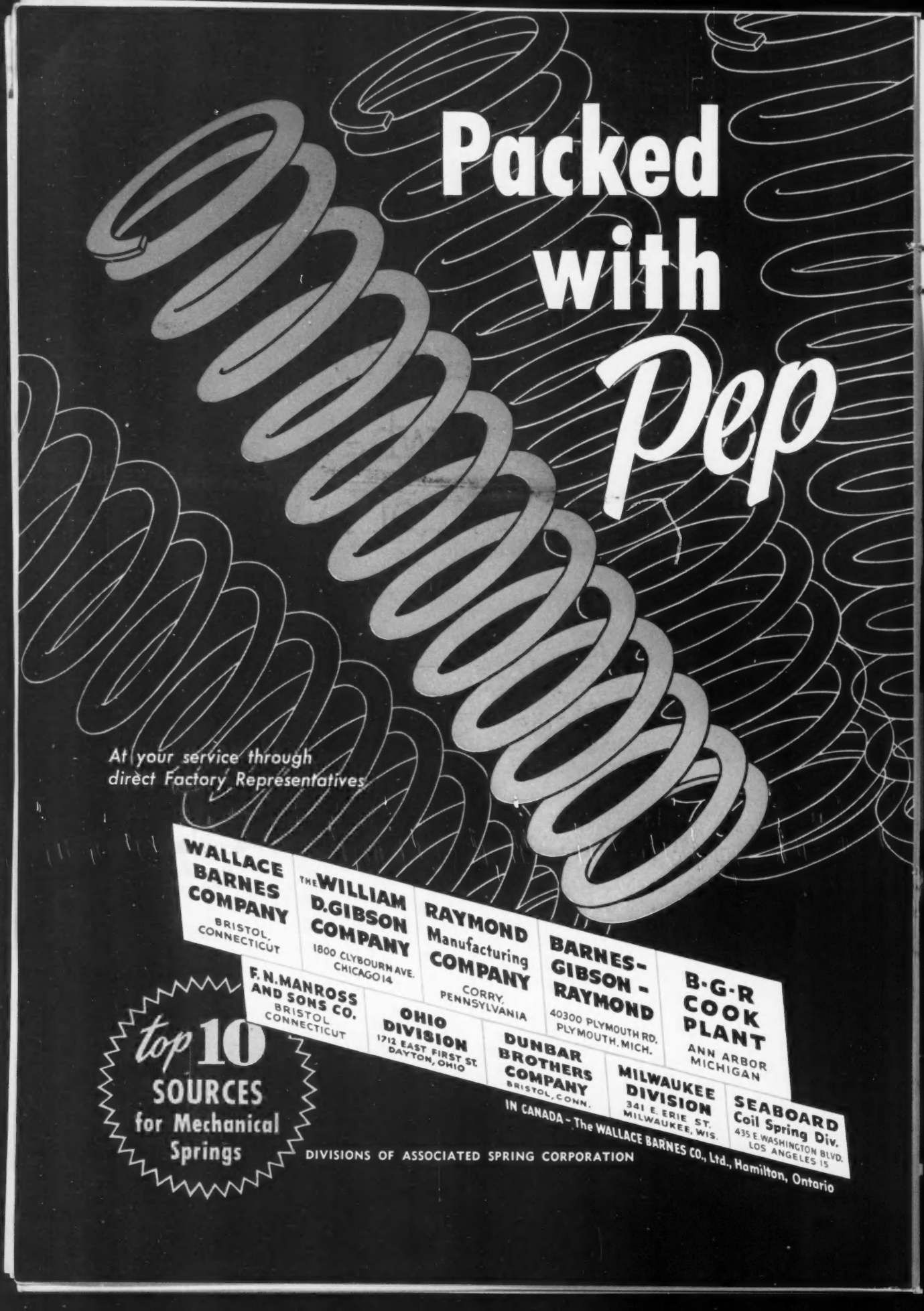
Standard V5 Skinner stainless steel solenoid valves, either 2 or 3 way, are available with dozens of options to meet special needs for control of liquid or gaseous media. Such options include *by-pass, metering, manual override, various electrical connections and port locations, manual reset,* etc. Standard valves from 5 to 250 p.s.i.—specials from 5 to 1500 p.s.i. Power consumption, 10 watts max. Soft insert seats prevent leakage, and spring loading assures positive action. Large capacity, yet only 2¾" high x 1⅝" dia. Send your standard or special requirements to Skinner—write for Bulletin 501 for complete details.

SKINNER ELECTRIC VALVES

Skinner ELECTRIC VALVE DIV.

THE SKINNER CHUCK COMPANY
® 114 Edgewood Ave., New Britain, Conn.

Alive with
action
Complete Production and Engineering Facilities at each plant —
WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT
THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14
RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA
BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.
B-G-R COOK PLANT
ANN ARBOR MICHIGAN
F. N. MANROSS AND SONS CO.
BRISTOL, CONNECTICUT
OHIO DIVISION
1712 EAST FIRST ST. DAYTON, OHIO
DUNBAR BROTHERS COMPANY
BRISTOL, CONN.
MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.
SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD. LOS ANGELES 15,
top 10 SOURCES for Mechanical Springs
IN CANADA - The WALLACE BARNES CO., Ltd., Ham
DIVISIONS OF ASSOCIATED SPRING CORPORATION


Packed with Pep
At your service through direct Factory Representatives
WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT
THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14
RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA
BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.
B·G·R COOK PLANT
ANN ARBOR MICHIGAN
F. N. MANROSS AND SONS CO.
BRISTOL, CONNECTICUT
OHIO DIVISION
1712 EAST FIRST ST. DAYTON, OHIO
DUNBAR BROTHERS COMPANY
BRISTOL, CONN.
MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.
SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD. LOS ANGELES 15
top 10 SOURCES for Mechanical Springs
IN CANADA - The WALLACE BARNES CO., Ltd., Hamilton, Ontario
DIVISIONS OF ASSOCIATED SPRING CORPORATION

we have to know what we're doing!

METAL POWDER PARTS BY MORAINE

For more than a quarter of a century we've been successfully making metal powder parts... *billions* of them... because we have that vital commodity—a combination of knowledge and experience called *know-how*.

Our metal powder parts are doing more and better jobs for industry every day and we offer our customers an ever widening choice of materials for ever broader applications. Moraine parts have close tolerances, improved physical properties, and are produced in ever more complicated designs.

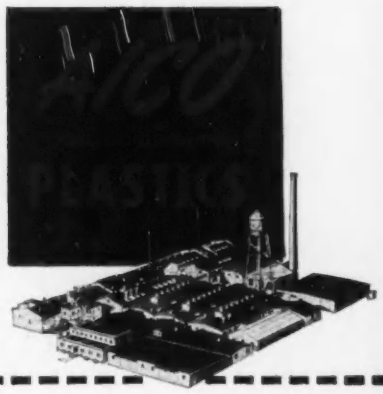
New customers for parts that can be produced practically by the powder metallurgy process are still being considered by Moraine. Volume must be sufficient to justify tooling so that benefits can be shared mutually.

m moraine products

DIVISION OF GENERAL MOTORS CORPORATION • DAYTON, OHIO

Don't miss the boat

Jump aboard . . . ride the cost and trading advantages of plastics to increased profits. Plastic parts are easily molded to extremely close tolerances . . . eliminate many production steps entirely to cut costs. The pleasing texture . . . adaptability to unique design . . . and unlimited color range of molded plastics assure smooth selling ahead for your products.



Send for Free AICO Plastics Applicator

FREE *Aico Plastics Applicator picks the right plastic for your product. A turn of its dial automatically selects the three best plastics for each purpose . . . even indicates the best molding method for each! Send for your Plastics Applicator and see how it can help you score extra profits. Mail the coupon today.*

American Insulator Corporation

New Freedom, Pennsylvania

Please send my free Plastics Applicator immediately.

NAME:_____

POSITION:_____

COMPANY:_____

ADDRESS:_____

☐ Have your representative call on me.

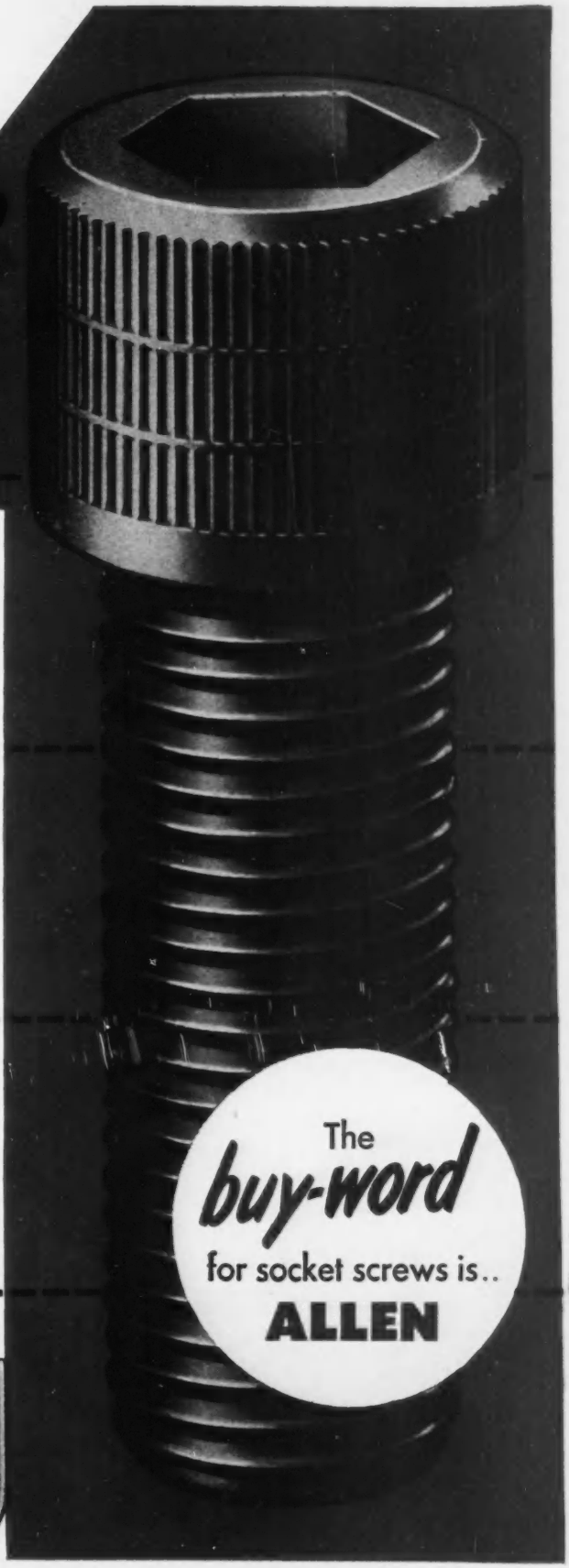
AICO'S COMPLETE PLASTIC MOLDING SERVICE INCLUDES: Engineering Counsel; Mold Building; Injection, Compression and Cold Molding plus the molding of reinforced plastics.

The

Number One

name in socket screws..

ALLEN



with design engineers...

No. 1 because Allen's greater strength, greater holding power and freedom from projecting heads permit more compact design and smooth, safe surfaces.

on the production line...

No. 1 because Allen ○ Heads' superior uniformity is maintained by statistical chart control. Burr-free threading and keying speed assembly time.

with the end user...

No. 1 because Allen ○ Screw products identify equipment that is designed right, built right. Allen screws, with more durable threads and sockets make adjustments, disassembly and reassembly easy and trouble-free.

. . . Sold only through leading distributors.

The *buy-word* for socket screws is.. **ALLEN**

ALLEN ALLEN HEAD

MANUFACTURING COMPANY

Hartford 2, Connecticut, U. S. A.

what are your DELIVERY requirements FOR hydraulic pumps?

If you need **PROMPT** delivery to expedite production...

If you need **PUMP** delivery from .4 to 40 gallons per minute . . . at operating pressures up to 1000 p.s.i. (in some sizes, 1200 p.s.i. continuous, 1500 p.s.i. intermittent) . . . with the smoother, more uniform flow produced by the highly efficient Gerotor mechanism . . .

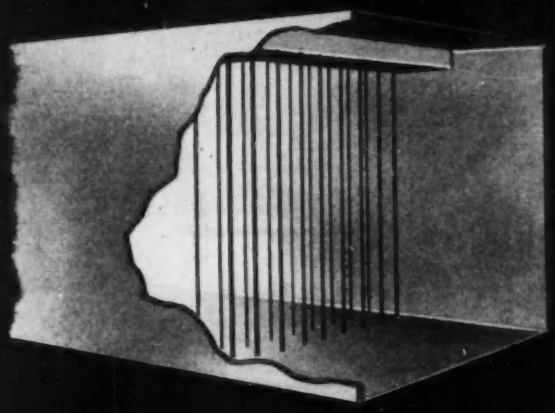
specify GEROTOR hydraulic pumps

GEROTOR MAY CORPORATION, BALTIMORE 3, MARYLAND

BIG or small-We make 'em All!

TK* ELECTRICAL HEATING ELEMENTS

standard or custom made



FOR DUCT HEATERS...

OR ROOM CONDITIONER HEATERS

You name your heating problem . . . we'll have the answer for it . . . quickly, easily, and at a price that is both practical and economical.

Whether it's a new feature to spark sales . . . like a room conditioner equipped for "fresh air—heated for winter operation" . . . or a more complex heat application similar to the duct heater . . . the TK "headquarters for heat" can serve you.

And . . . the chances are *good* that we may have *already* solved a similar problem that will fill your needs exactly . . . at a considerable saving in time *and* money for you. That's because our *only* business is electric heat.

Our men are experts . . . their know-how stemming from years of consistent effort and research concentrated in this field. We work at it every day . . . for many different manufacturers . . . on many different products.

Why let a heating problem get you down? Instead, seek the advice of experts . . . *TK!* You'll profit by the intelligent "personalized" service . . . based on experience and know-how . . . which results in better units for you. Write today for complete information.

*T. M. Reg. U. S. Pat. Off.

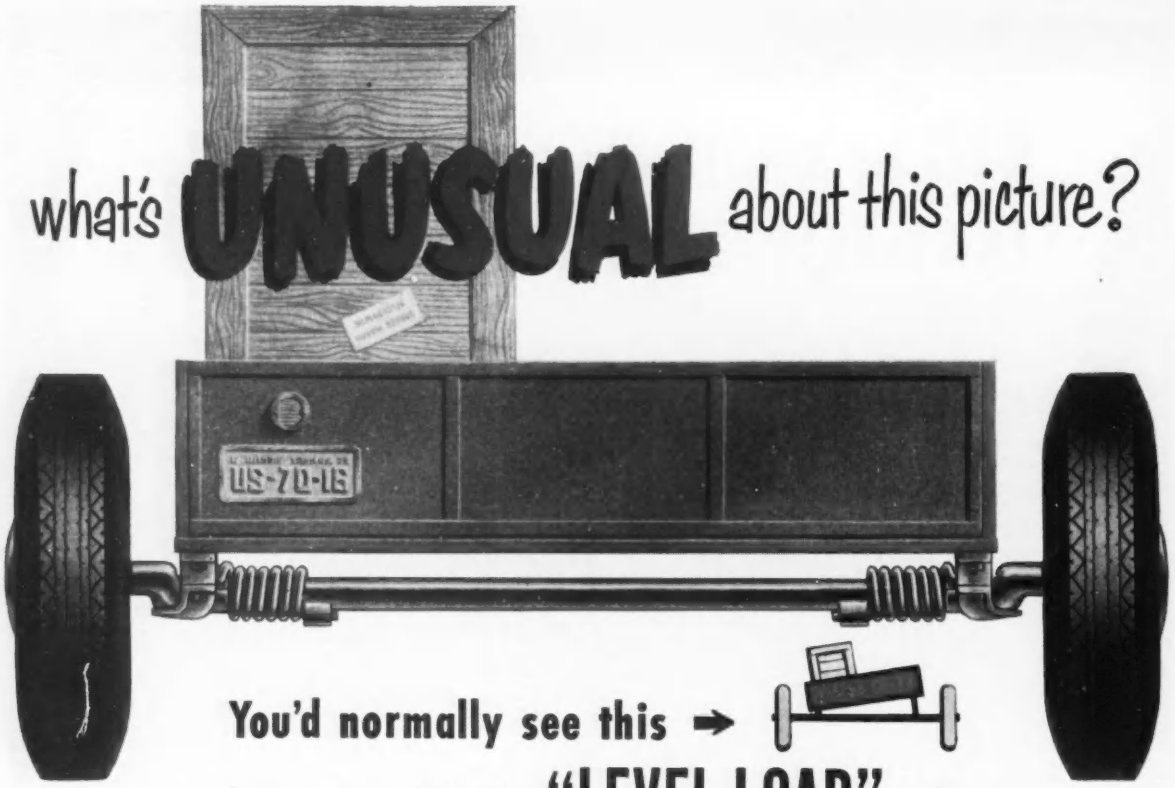
TK FERRO

TUTTLE and KIFT, INC.

A Subsidiary of Ferro Corporation

1831 N. MONITOR AVE. • CHICAGO 39, ILLINOIS

what's UNUSUAL about this picture?



You'd normally see this ➡

but not with the "LEVEL-LOAD" axle!

An axle that evenly distributes load weight on both springs—*regardless of load placement*—can't help but offer makers of towed equipment more freedom of design and layout. And it's here now . . . the ASF-Linco "Level-Load" axle!

Each end of this unique axle has a spring-controlled floating spindle arm, forged as a solid, integral unit with the steel shaft. Road shock on one wheel, or an off-center weight, is absorbed by both springs—*equally and simultaneously*. The inevitable result is a load that stays level without tilting or sidesway; a load that tracks better and pulls evenly on the drawbar.

And, as the spindle arm moves downward with increased loads, spring leverage *decreases*. Spring tension and load weight are automatically maintained in easy-riding proportion to each other!

If you design any kind of towed equipment . . . welding machines, sprayers, utility trailers, mixers, etc. . . . get all the facts on towing at its level best! Write American Steel Foundries, 410 North Michigan Avenue, Chicago 11, Illinois.

The NEW axle that adds NEW features to towed equipment!

Load Stays Level—No tip, no sidesway to cause uneven drawbar pull.

Easier Riding—With spring tension that automatically adjusts to load weight.

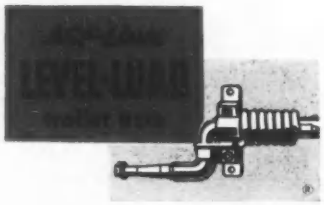
Bigger Capacity—Than any other axle of similar rating.

Simple Design—Eliminates spring leaves, shackles, snubbers, U-bolts.

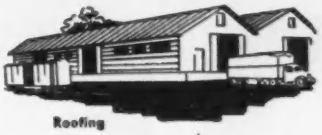
Less Maintenance—Fewer parts to wear. Easily renewable friction bearing insert.

Low Center of Gravity—For greater stability, and a road-hugging ride.

And, easy to install on your production lines! It's a completely assembled unit. Just 4 bolts (single) or 8 bolts (tandem). No equalizing bars needed in tandem mounting.

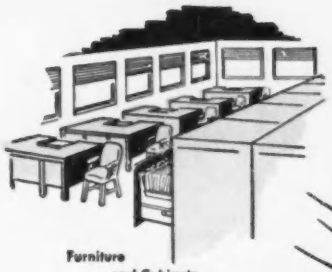


AMERICAN STEEL FOUNDRIES



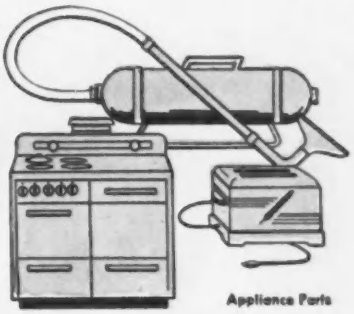
Roofing

Signs and Labels

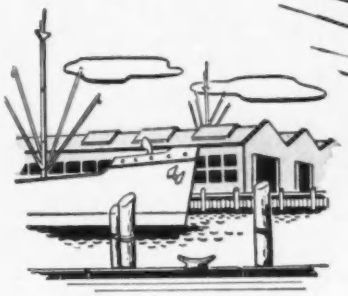


Furniture and Cabinets

NEW HORIZONS for ALUMINUM



Appliance Parts



Marine Applications and Many Other Uses

now made possible with DU PONT VITREOUS ENAMEL

Get all the advantages of aluminum— in colors that help your product sell better

EASE OF FABRICATION

WIDE COLOR APPEAL

DURABILITY

INCREASED STRENGTH

EASE OF APPLICATION

The remarkable properties of Du Pont vitreous enamel for aluminum permit a new, wider use of lightweight aluminum alloys. This outstanding protective finish enables you to take advantage of aluminum's desirable features in a variety of structural and decorative applications. And Du Pont vitreous enamel adds a wide color appeal to your household and industrial products—gives them another important sales advantage.

Vitreous enameled aluminum can be sheared, sawed, drilled and punched without damage to the coating. Costly prefabrication is eliminated because standard size enameled sheets can be cut to size on the job.

Almost unlimited range of colors and degrees of surface gloss available . . . can be produced in multi-color effects by masking, spray or screen stencil processes.

Du Pont vitreous enamel for aluminum is lightfast . . . displays excellent resistance to corrosion, abrasion, thermal shock, impact and flexing . . . has a high dielectric strength.

A standard thickness coating of vitreous enamel increases the rigidity of sheet aluminum as much as 60%!

Vitreous enamel is readily applied by ordinary enameling and firing procedures.

FOR MORE INFORMATION SEND FOR YOUR FREE COPY OF THIS BOOKLET

Vitreous enamel for aluminum is fully described in this free booklet—just fill out and send in the coupon below.

DU PONT
VITREOUS ENAMEL
FOR ALUMINUM

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Department, Wilmington 98, Delaware

Please send me a free copy of your booklet on Du Pont Vitreous Enamel for Aluminum. I am interested in enameling the following types of work_____

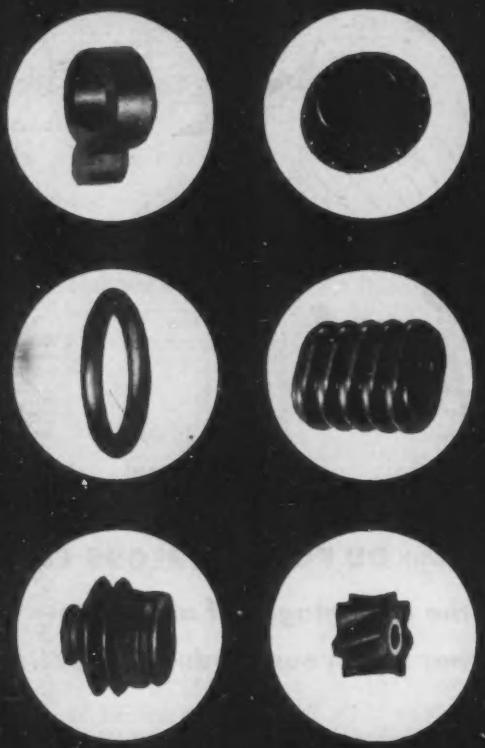
_____

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____



It's the fit that pays dividends...

LINEAR moulded parts pay dividends in easier assembly and in elimination of costs for reworking assemblies rejected because of faulty or cheaply made rubber pieces.

EVERY PIECE COUNTS when you use LINEAR mouldings. They are precision-made to the closest possible tolerances—to give you:

- Easier installation
- Lower rejection rate
- Closer maintenance of promised schedules

Whenever you require accurately dimensioned seals or odd-shaped parts of natural or synthetic rubbers, fluorethylene polymers or silicones, consult LINEAR in the design stage. Let LINEAR transform your ideas into precision-moulded finished goods!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.

Wear Defying

SILVER KING

INDUSTRIAL COUNTERS

Silver Kings challenge comparison! On casual examination, critical analysis, or the most exhaustive life tests they come out miles ahead.

Built rugged as an army tank, they operate smooth as a watch. Extra heavy shaft, oversize bearings, life-tested parts, light weight number wheels, tamper-proof reset, all-steel housings, chrome-plated finish—you can install Silver Kings with assurance of maximum dependability, longest life, lowest upkeep cost.

Available in Stroke and Revolution types, 5- or 7-digits, right or left shaft, knob or key reset.

Ask your PIC Representative to show you a Silver King or write us.

PRODUCTION INSTRUMENT COMPANY
700-04 W. Jackson Blvd., Chicago 6, Ill.

FLEXIBLE COUPLINGS

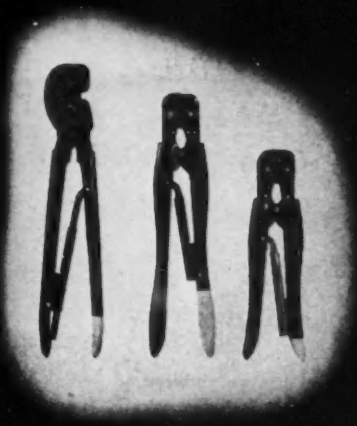
Soundly engineered, LOVEJOY Flexible Couplings provide maximum alignment correction for smooth power transmission. Vibration, starting torque and shock of intermittent loads are dampened and absorbed. Operational efficiency and economy is increased, motor and machine protected—their service life lengthened. The end result is not only a more profitable, but an improved finished product.

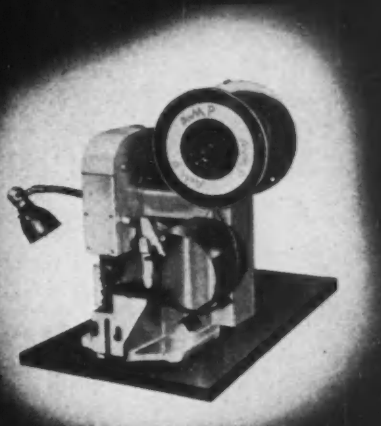
There is a LOVEJOY Flexible Coupling for every requirement. Cushions are made of materials best suited to the load conditions.

Write today for Catalog and Handy Selector Charts

LOVEJOY FLEXIBLE COUPLING CO.

5073 W. Lake Street **Chicago 44, Illinois**
Also Mfrs. of Lovejoy Universal Joints and Variable Speed Transmissions

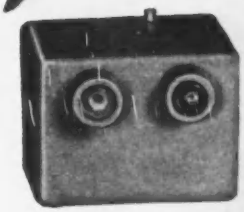




it's the Extra Factor of Assurance that counts...

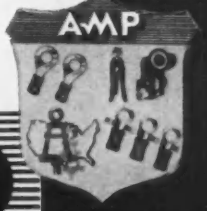
All the gadgets or combination tools in the world will not insure the correct installation of your wire terminations day in, day out, on the line. It's the extra factor of assurance that counts! AMP tools and terminals are made to use together. They're made so that you can be *sure* that you have a correctly installed termination. AMP application tools and dies and automatic machines are so designed that at the point of application you can control accuracy and uniformity within ±.003". Remember: In wire termination there is no short cut to precision and foolproof production!

Shown below: AMP CERTI-CRIMP® hand tools—will not release until proper crimping pressure has been reached. (Below right) the AMP INSPECTO-MASTER® gives continuous inspection at point of terminal application. Write to AMP for information about these and other recent developments in wire termination.

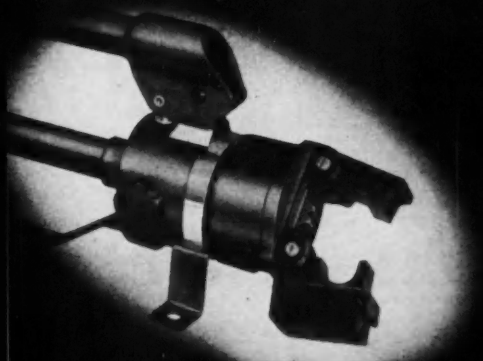


A-MP CONTROLLED WIRE TERMINATION

YOU CAN COUNT ON AMP



AMP



AIRCRAFT-MARINE PRODUCTS, INC.

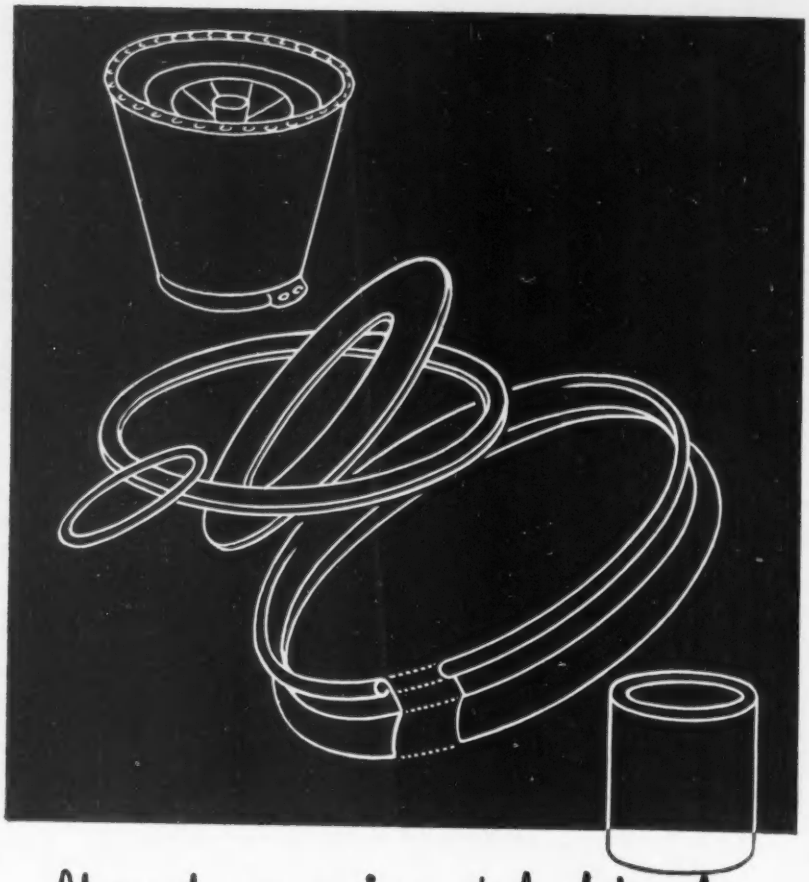
2100 Paxton Street, Harrisburg, Pa.

Canadian representative:
1583 Eglinton Ave. West Office 1-A Toronto, Ontario

AMP Trade-Mark Reg. U.S. Pat. Off.

*Trade-Mark

GO "AMERICAN" FOR CIRCULAR WELDED PRODUCTS



If any of your requirements lend themselves to any welding process, we believe that our 34 years of welding and fabricating "know how" put to work for you will provide you with worth-while manufacturing economies. All you have to do is drop us a line.

Send for your copy of our 20 page illustrated catalog

THE AMERICAN WELDING & MANUFACTURING CO. · WARREN, OHIO

LET US SEND YOU MORE FACTS OR BETTER YET SEND US YOUR SPECIFICATIONS FOR PROMPT QUOTATIONS

TEST your HORSEPOWER sense!

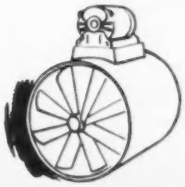
Can you state the H.P. needed for these jobs?

CHECK ONE: ( )1/8-h.p. ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p.

Right you are . . . the vast majority of refrigerators contain one-eighth h.p. motors. But did you know that more refrigerators are powered by Delco Motors than by any other make? It's a fact. Manufacturers appreciate Delco dependability!

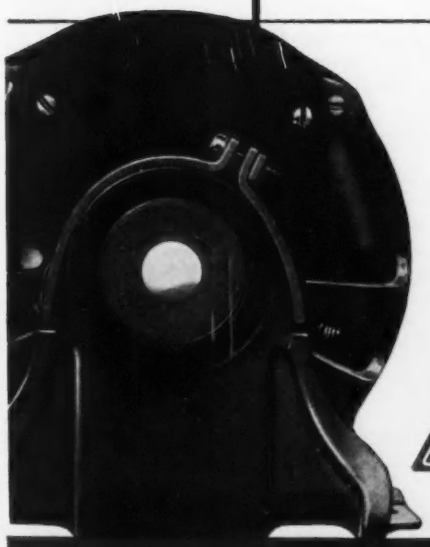
CHECK ONE: ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Right again! Most washing machines use one-third h.p. motors . . . and more and more manufacturers of washing machines are installing Delco Motors in their products. Delco's dynamically balanced rotor, and Delco's steel-backed babbitt bearing with cored oil wells mean long trouble-free service—always.



CHECK ONE: ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Correct . . . it depends on the size of blower required. So remember · Delco motors for blowers are available in all standard h.p. ratings . . . and Delco motors are favorites with furnace makers, due to their efficient, ultra-quiet operation.



DELCO

The best running mate your product can have!

DELCO PRODUCTS

Division of General Motors Corporation • Dayton, Ohio

SALES OFFICES: Atlanta • Chicago • Cincinnati • Cleveland
Dallas • Detroit • Hartford • Philadelphia • St. Louis • San Francisco

This new booklet shows you how Kodak Contour Projectors can simplify your inspection and measurement problems

Just off the press is the most informative booklet on Kodak Contour Projectors we've ever published.

- It shows by example and case history how you can inspect large parts, small parts, long parts, curved parts, delicate parts, complex parts, all sorts of parts on the Kodak Contour Projector.
- It gives details of both the Model 2A for precision micrometry, and the Model 3 for fast, routine gaging.
- It describes the features that make Kodak Contour Projectors adaptable to such a wide variety of work.
- It lists the accessories that extend their versatility.
- It discusses the measuring attachments that provide critical accuracy.

Whether your interest lies in toolroom measurement or production assembly and inspection, Kodak Contour Projectors will do the job quickly, completely, and accurately with little training of operators. For complete details, send for your complimentary copy of this new 12-page booklet. Just write to Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Optical Gaging

A new sound movie, Optical Gaging, shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

Kodak

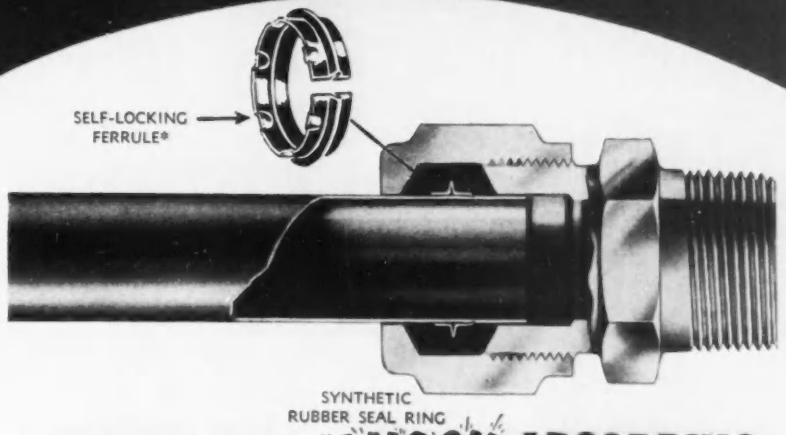
ROLL CALL OF SEALASTIC USERS

- **AIRCRAFT ENGINES**
  - Allison Division—General Motors Corp.
  - Bendix Products Division—Bendix Aviation Corp.
  - Pratt & Whitney Aircraft—Division United Aircraft Corp.
  - Wright Aeronautical Corp.—Division Curtiss-Wright Corp.
- **AUTOMOTIVE**
  - Buehl Manufacturing Co.
  - Continental Motors Corp.
  - Ford Motor Company
  - Packard Motor Car Co.
- **BUSES**
  - ACF Brill Motors Co.
  - Canadian Car & Foundry
  - General American Aerocoach—Div. General American Transportation Corp.
  - Twin Coach Co.
- **FOOD PROCESSING**
  - The Liquid Carbonic Corp.
- **MACHINERY**
  - Allis-Chalmers Mfg. Co.
  - Detroit Diesel Engine Division—General Motors Corp.
- **OIL WELL MACHINERY**
  - Cardwell Mfg. Co., Inc.
- **RAILWAY**
  - The Budd Company
  - Electro-Motive Division—General Motors Corp.
- **REFRIGERATION**
  - Howe Ice Machine Company

THESE NOTABLE NAMES IN AMERICAN INDUSTRY DEPEND ON

Sealastic

ALL-PURPOSE FITTINGS



THE FITTING THAT IS SHOCK ABSORBING AND VIBRATION-FATIGUE PROOF FOR LOW, MEDIUM AND HIGH PRESSURES

By eliminating metal-to-metal contact between tube and fitting SEALASTIC ends your problem of leaks and breaks caused by shock and vibration-fatigue. Overcomes tube misalignments. Permits dependable, cost-saving, straight-line-tubing between fixed points.

This cushioned-coupling design provides a seal ring of synthetic rubber, surrounding a ferrule (either self-locking or solid ring swaged, sweated or brazed).

Seal ring prevents metal-to-metal contact and cushions against vibration. Nut only needs to be tightened by hand to place entire seal under compression (to withstand pressure up to 4,000 p.s.i.).

Substantial time and labor savings in assembly work or emergency repairs are made possible because Sealastic Fittings are engineered and integrated to your special requirements.

The varied industries listed at the left are proof of Sealastic's practical application wherever fuel, oil, water, refrigerants, air or ether injection must pass through metal tubes or piping.

May we send you descriptive booklet and full details of Sealastic engineering service?

*For critical applications, we recommend the solid ferrule fixed on the tube.

CHICAGO FORGING & MFG. CO.

Automotive Parts Manufacturer since 1922

2000 SOUTHPORT AVENUE • CHICAGO 14, ILLINOIS

Sales representatives: some territories still open. Write for details.

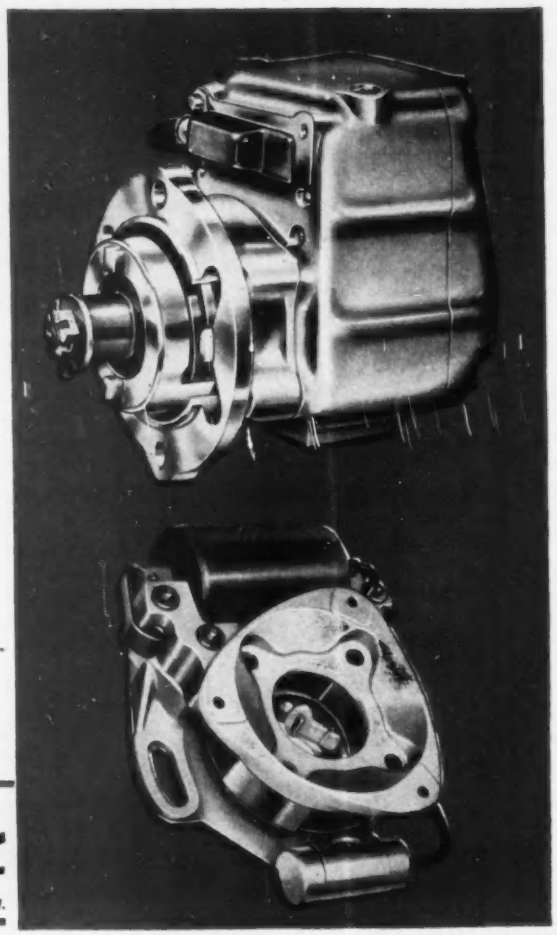
WOULD YOU LIKE
LONGER LIFE
and FREEDOM
from BREAKDOWNS
IN YOUR SMALL ENGINES?

Specify

BENDIX

THE MOST TRUSTED NAME
IN MAGNETOS

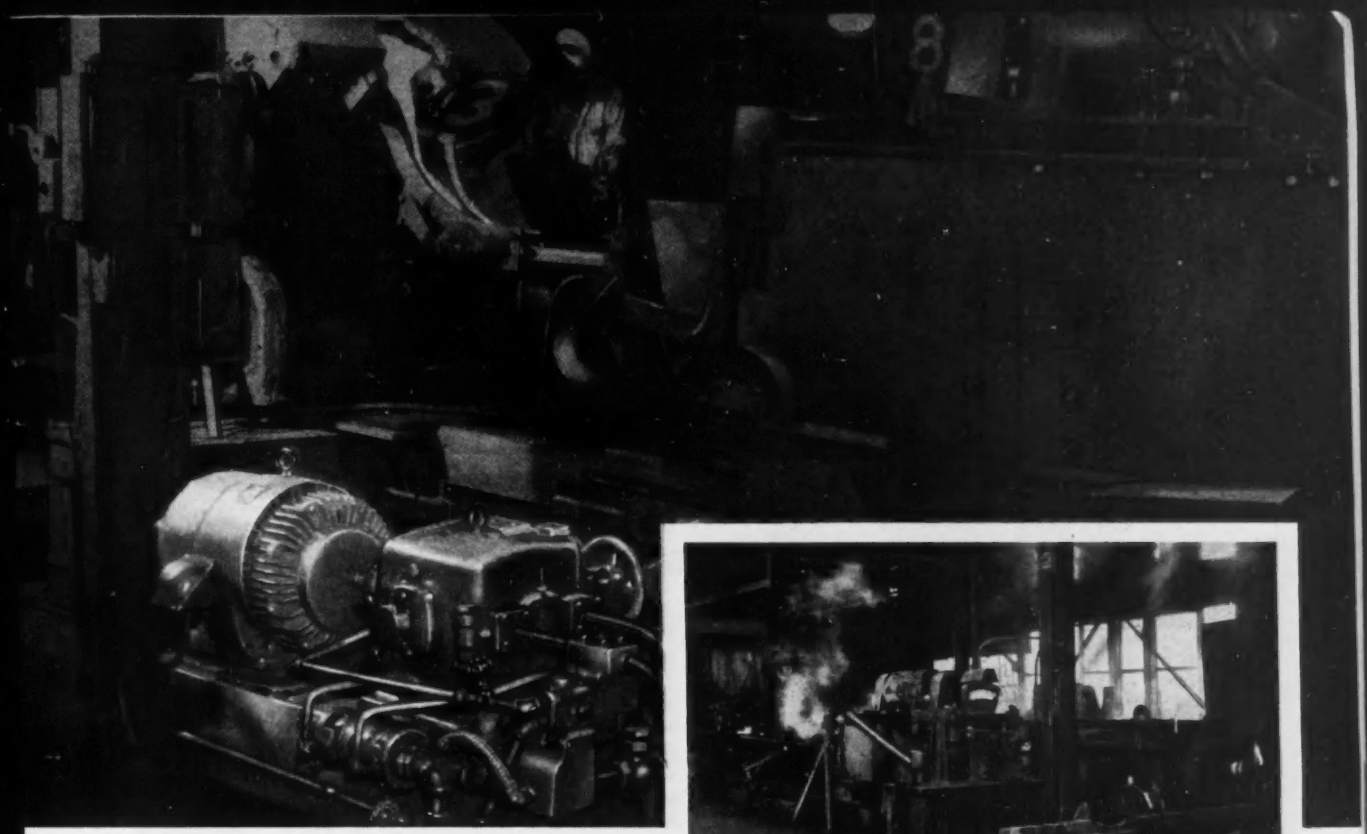
✓Simplicity in design.
✓Waterproof moulded coil.
✓Lower operating cost.
✓Minimum lubricating requirement.
✓Light in weight.
✓Higher voltage at starting speed.
✓Constant spark over entire speed range.
✓Compact and sturdy construction.

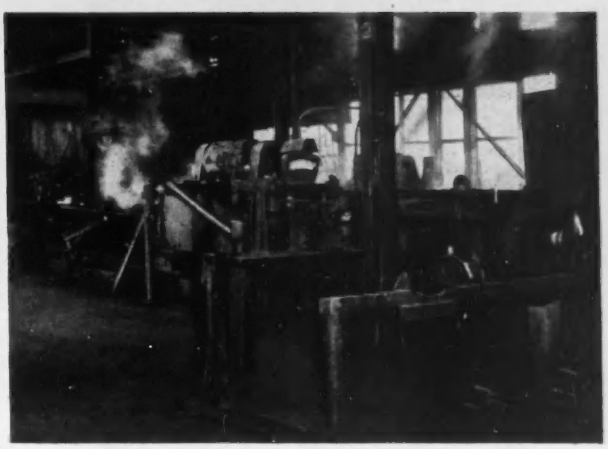


Whether you purchase a small engine for outboard, industrial or marine use, today's foremost consideration should be long life and trouble-free performance. Therefore, it will pay you well to insist on Bendix magnetos in the engine you select. For the basic design of Bendix magnetos assures quality performance for *every type* of small engine and *every pricing requirement.* Remember it pays to specify Bendix, the most trusted name in magnetos. Complete information available on request.

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK
Bendix
Export Sales: Bendix International Division
72 Fifth Avenue, New York 11, N.Y.
Bendix AVIATION CORPORATION

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California





OILGEAR DRIVES ON GLAMORGAN CENTRIFUGAL PIPE CASTING MACHINE

Something more than 5 years ago, the Glamorgan Pipe & Foundry Company, of Lynchburg, Va., a leading manufacturer of cast iron pipe, designed its own centrifugal pipe casting machine, using Oilgear Fluid Power equipment to tilt the ladle and move the casting carriage.

The degree of control over pouring rate and carriage travel afforded by Oilgear has had almost unbelievable results. Scrap caused by irregularities in moving parts has become negligible. Weight controls are well within the close limits set by Industry specifications. Only 3 men are needed to operate the equipment. Despite the fact the machine has averaged 500 operations per day since 1948, maintenance on Oilgear equipment has totaled less than $200.00. The fumes and dirt necessarily present in foundry operations have had no effect on Oilgear fluid power equipment.

TYPICAL OF OILGEAR'S ABILITY TO SOLVE MACHINE DESIGN PROBLEMS

Sure it takes power to tilt a ladle and move a pipe casting machine carriage. But above all, it takes absolute and precise control of the speed of pouring and the speed of carriage travel if the product is to be perfect and uniform.

It not only takes power but power under control to print in register on flimsy cellophane at high speed, to set up paper piles for repetitive serial cuts to hairline register automatically, to cut fish on a continuous conveyor to accurate weight for canning, to vary the speed of a large beater automatically to conform sensitively to the changing viscosity of the mass.

These are all triumphs of Oilgear Fluid Power—where this flexible, controllable, versatile power leads the way to better machine design or to the solution of hitherto unsolved problems.

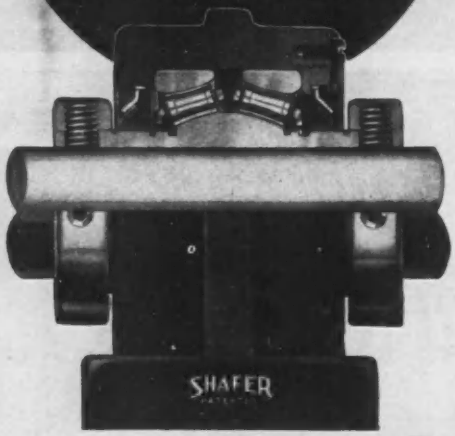
Think of Oilgear Fluid Power as identical with electrical power . . . generated by a pump . . . applied over conductors through a motor or motor element. But Oilgear Fluid Power can be converted into linear movement as well as rotary; can be exerted statically, without motion; can be varied infinitely, steplessly without additional equipment.

And the unique Oilgear design is oil hydraulic design at its simplest and best. It is generally accepted as the leader in its field. It will cost you nothing to see what Oilgear can do to improve the salability of your equipment . . . may profit you and your users in an amazing degree. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

OILGEAR

THE *Rugged* JOBS ARE "*Routine*" FOR SHAFER BEARINGS



Throughout the land Shafer Roller Bearings are increasing the nation's productive capacity—carrying big loads, saving money and power, reducing down time and maintenance costs wherever America's heaviest duty power transmission equipment is at work.

Shafer Bearings handle these tough jobs better because they are engineered to-the-job—to provide *longer* life, greater dependability and *lower* operating costs under the severest working conditions. Integrally self-aligned, they have full radial-thrust and greater reserve shock load capacities under all conditions of misalignment; are equipped with self-centering "Z" housing seals and Micro-Lock 12-point adjustment. See the Shafer bearing specialist near you . . . or write us direct . . . for complete information and engineering consul on a no-obligation basis. SHAFER BEARING CORPORATION, 801 Burlington Avenue, Downers Grove, Illinois.

Pillow Blocks

Flange Units

Flange Cartridge Units

Cartridge Units

Duplex Units

Take-Up Units

Unmounted Bearings

SHAFER

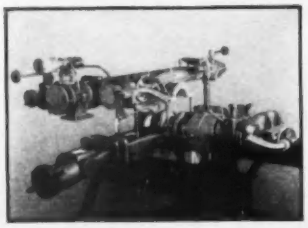
SELF-ALIGNING

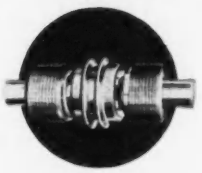
ROLLER BEARINGS

Take-Up and Frame Units

Aircraft Control Bearings

Fights Big Fires With





—High Pressure Fog

The Hale MULTI-SERVICE PUMP for fire-fighting engines, must supply 500 to 600 gallons per minute at 600 to 700 pounds pressure P.S.I. ROCKFORD CLUTCHES provide the power transmission control required for reliable high impeller speed. Let ROCKFORD clutch engineers help with your difficult power transmission problems.

ROCKFORD CLUTCH DIVISION
209 Catherine Street, Rockford, Illinois, U. S. A.

B-W ENGINEERING MAKES IT WORK

B-W PRODUCTION MAKES IT AVAILABLE

ENGINEERING BULLETIN SENT ON REQUEST

ROCKFORD CLUTCHES

ROTATING or STATIONARY ASSEMBLIES held together EASIER with

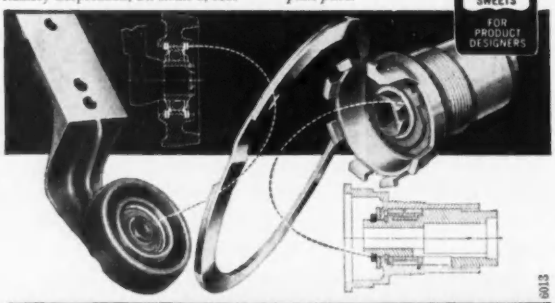
SpirOlox Retaining Rings

Conveyor roller application at left shows how Spirolox attains neat, compact, simplified design, even on rotating assemblies. Stationary application of lock assembly illustrates how Spirolox can be applied to hard-to-reach places where retaining ring must operate in very confined space. Secret of Spirolox adaptability is patented *two-turn* construction, which makes possible unique locking characteristic . . . will not jump out of groove. Always provides a uniform shoulder . . . no lugs, no gap.

FREE DATA BULLETIN
Send blueprint of your retaining problem. Ramsey Corporation, St. Louis 8, Mo.

U. S. Pat. No. 2,450,425 and Foreign Pats. Other pats. pend.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS



6013

Rotating or Stationary

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

Cut Your V-Belt Costs Right Now!

—this test tells how!

If you want longer V-Belt wear and lower V-Belt costs just make this simple test. Bend any V-Belt that has *straight sides* and—as it bends—*feel* the sides bulge out! (See Fig. 1-A, below)

This out-bulge forces the belt to press unevenly against the V-pulley and of course wear on the belt is concentrated where it bulges most. Naturally this shortens the life of a *straight-sided* V-Belt.

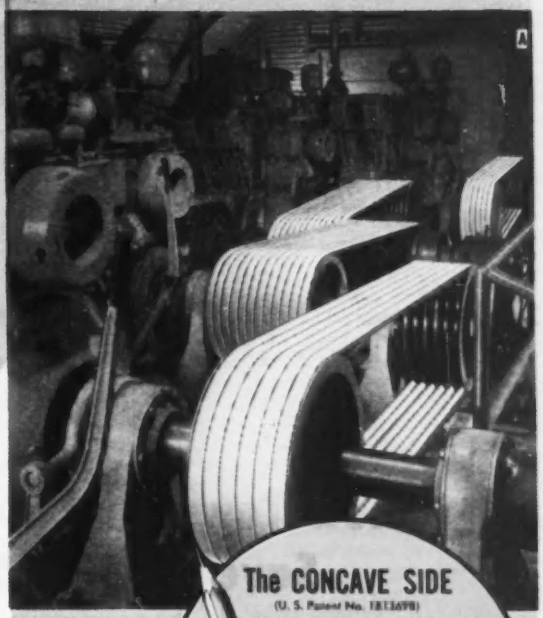
Now, make this same test with the belt that is built with *concave sides*—the Gates Vulco Rope!

See the difference? There is no *out-bulge!* The precisely engineered concave sides *fill out* and become *perfectly straight.* They now *exactly fit* the sheave groove and therefore *press evenly* against the V-pulley. This distributes all wear *uniformly* across the *full width* of the Gates Vulco Rope. And this means longer belt life and *lower belt costs* for you.

Only V-Belts made by Gates are built with concave sides. Whenever you buy V-Belts, be sure that you get the V-Belt with Concave Sides—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

Multiple engines and generators were installed to supply power during the development of Chicago, Wilmington and Franklin Coal Company's Waltonville, Illinois, Coal Mine. The engines had to be connected to the generators with a drive that would absorb vibration and also be completely reliable—so these Gates V-Belts were installed. Mr. Rodenbush, Superintendent, says, "The Gates Vulco Rope Drives have been entirely satisfactory in every way."



What Happens When a V-Belt Bends

Straight-Sided V-Belt

How a Straight-Sided V-Belt Bulges in the Sheave-Groove. Sides Press Unevenly Against the V-Pulley, Causing Extra Wear at Point Shown by the Arrows.

Gates Vulco Rope With Concave Sides

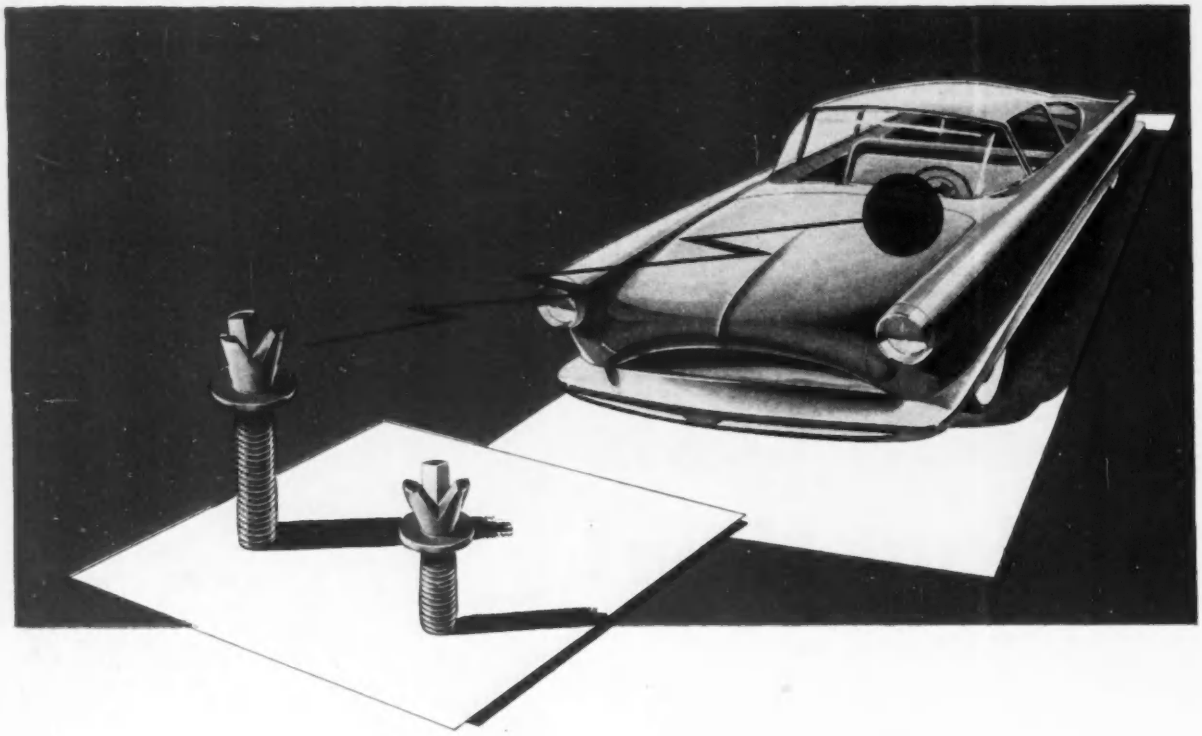
The Concave Sides Fill Out to Precise Fit in Sheave-Groove. No Side-bulge! Sides Press Evenly Against the V-Pulley —Uniform Wear and Longer Life!

CS-531

Gates® VULCO ROPE DRIVES

THE GATES RUBBER COMPANY • DENVER, U.S.A.

V-Belts—Hose Molded Rubber Goods for industry World's Largest Maker of V-Belts



How Townsend Helped A Manufacturer Save $5,130 On One Small Part

In the automotive industry's constant search for new ways to improve products without increasing unit costs, they find Townsend's method of producing fasteners and small parts invaluable.

For example, the terminal posts shown above, which are molded into plastic blocks for use in the electrical circuits of autos, were formerly made by another method at a cost of $3.00 per thousand. By the Townsend method of cold-heading and thread rolling, it was produced for only $2.28 per thousand—a saving which totals approximately $5,130 per year.

This is one of many typical examples of how Townsend, with a background of more than a century of wire drawing and cold-heading, saves money for all industry. We mass-produce fasteners and small parts at less cost—often reduce assembly time as well because of improved design.

Others find it pays to have Townsend study assembly methods and fastening problems. To learn how you can reduce costs—improve your products, send drawings or samples of any items you wish studied. We will give you ideas and estimates without obligation.

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

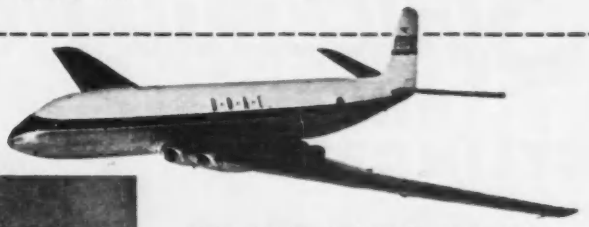
Sales Offices in Principal Cities

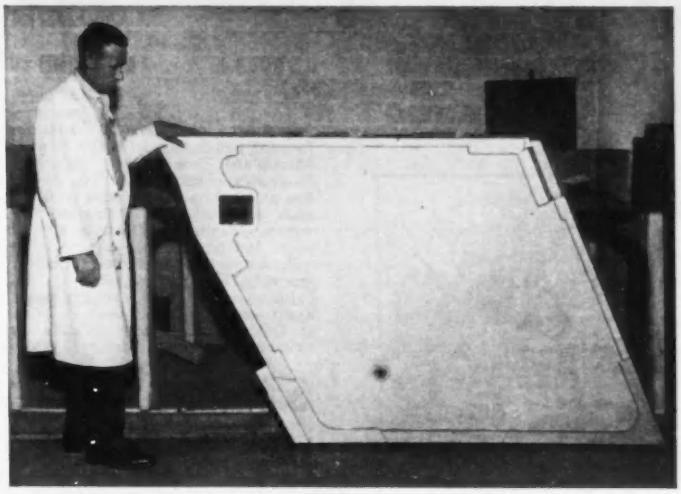
Cherry Rivet Division • Santa Ana, California

THE FASTENING AUTHORITY—Experience: *over 136 years*—**Capacity:** *sixty-million parts daily*—**Products:** *over ten-thousand types of solid rivets—cold-headed parts—Cherry Blind Rivets—Twinfast Screws—self-tapping screws—tubular rivets—locknuts—special nails—formed wire parts.*
Plants: *New Brighton, Pennsylvania—Chicago, Illinois—Plymouth, Michigan—Santa Ana, California.*

IDEAS *in the making*

Bonding, Casting and Coating Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. You will want to know more about them.





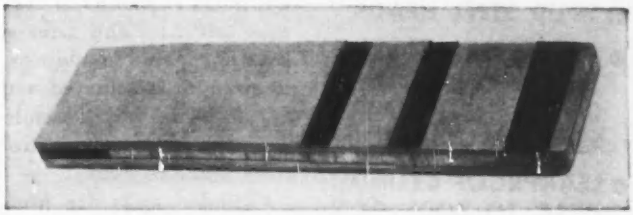
Shown above is a single curved wing panel used as a primary structure in a high performance Chance-Vought Aircraft jet. This type of construction is typical of Redux-bonded assemblies comprising metal-to-metal and metal to end-grain wood adhesive bonds.

Shown below is a section of a typical sandwich construction utilizing thick facings and end-grain wood core, bonded together with a structural adhesive. The internal doubler at the right illustrates how local reinforcements may be added and still retain flush contour.

OPENING A NEW ERA IN AIRCRAFT ENGINEERING

REDUX

The Redux Bonding Process, developed by Ciba's subsidiary, Aero Research in England, makes possible the rivetless assembly of primary structures in aircraft. The famed de Havilland "Comet" shown above was specifically designed to use the Redux Process in the assembly of its components, and was built directly from the drawing boards without a prototype. The acceptance of the Redux Bonding Process by the aircraft industry has been demonstrated further by its adoption as standard procedure in military types as well, such as the U. S. Navy's "Cutlass" jet fighter built by Chance-Vought.*



The achievement of ways and means to assemble aircraft components with the "Redux" Process as developed by Dr. N. A. de Bruyne, Ciba's distinguished associate from England, has won widespread engineering and public attention both here and abroad.

In response to long-standing invitations from American universities, engineering societies and aircraft companies, Dr. de Bruyne is now filling a specially arranged lecture itinerary to appear before these groups from coast to coast.

➡ REPRINTS OF PUBLISHED PAPERS BY DR. DE BRUYNE ON THE "REDUX" PROCESS and related data sheets have been assembled in a special reference file folder to serve as a preliminary guide to aircraft engineers in evaluating and using the "Redux" bonding process. Complete engineering assistance and information on the use of the process are available from Ciba.

*Reg. U.S. Pat. Off.

Ciba *Plastics*

★ BONDING ★ CASTING ★ COATING RESINS

CIBA COMPANY INC., PLASTICS DIVISION

627 Greenwich St., New York 14, N. Y.

(In Canada: Ciba Co. Ltd., Ciba Bldg., Montreal)

Please send me data on the Redux Bonding Process.

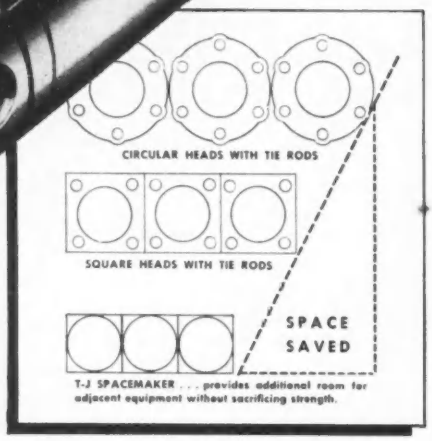
*Name*_____

*Company*_____ *Title*_____

*Address*_____

P.E. 2

NEW T-J Spacemaker AIR CYLINDERS


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
SPACE SAVED
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

- SAVES UP TO 40% SPACE WITH NEW STREAMLINED DESIGN.
- SUPER STRENGTH . . . EXTRA HIGH SAFETY FACTOR.
- SOLID STEEL HEADS.
- HEAVY WALL, PRECISION HONED, HARD CHROME PLATED SEAMLESS STEEL BODY.
- LEAKPROOF CYLINDER HEAD TO BODY CONSTRUCTION.
- RELATIVE PORT POSITIONS MAY BE ROTATED WITHOUT DISASSEMBLY OF CYLINDER AND LOCKED IN DESIRED POSITION.
- HEAVY DUTY, HI- TENSILE, HARD CHROME PLATED PISTON ROD.

Streamlined construction of the new T-J Cylinders *eliminates tie rods . . . reduces head size . . .* and *saves up to 40% in mounting space!* In addition, a new high in strength is achieved with solid steel heads and heavy wall seamless steel body . . . leakproof construction . . . extra high safety factor.

Cylinder walls are precision honed and hard chrome plated for long-life efficiency. Available with the new T-J Super Cushion Flexible Seals which insure positive cushion with automatic valve action for fast return stroke. Many standard sizes and styles . . . both cushioned and non-cushioned . . . for wide range of pushing, pulling, lifting, clamping or control jobs. T-J dependability. *Fast delivery* to meet rush requirements. Write for bulletin 8152. The Tomkins-Johnson Co., Jackson, Mich.

Many More Advanced Features!

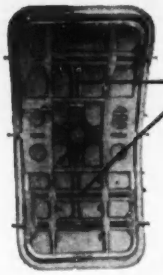
37 YEARS EXPERIENCE

T-J TOMKINS-JOHNSON

RIVITORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

SIMMONDS

ENGINEERING BRIEFS



Four Push-Pull Controls saved weight, engineering time and installation costs for forward passenger and cargo door of Martin 404. Four plungers operate by Simmonds controls, with two direct-line plungers on center. Bend is 90° on each push-pull, plus fit to door curvature. Maximum allowable applied load: 300 pounds.

Pre-formed, engineered controls save assembly, maintenance time . . . are lighter, cost less than alternate units. Eight similar controls used in doors of Douglas DC-6. For full data on control installations, write to:

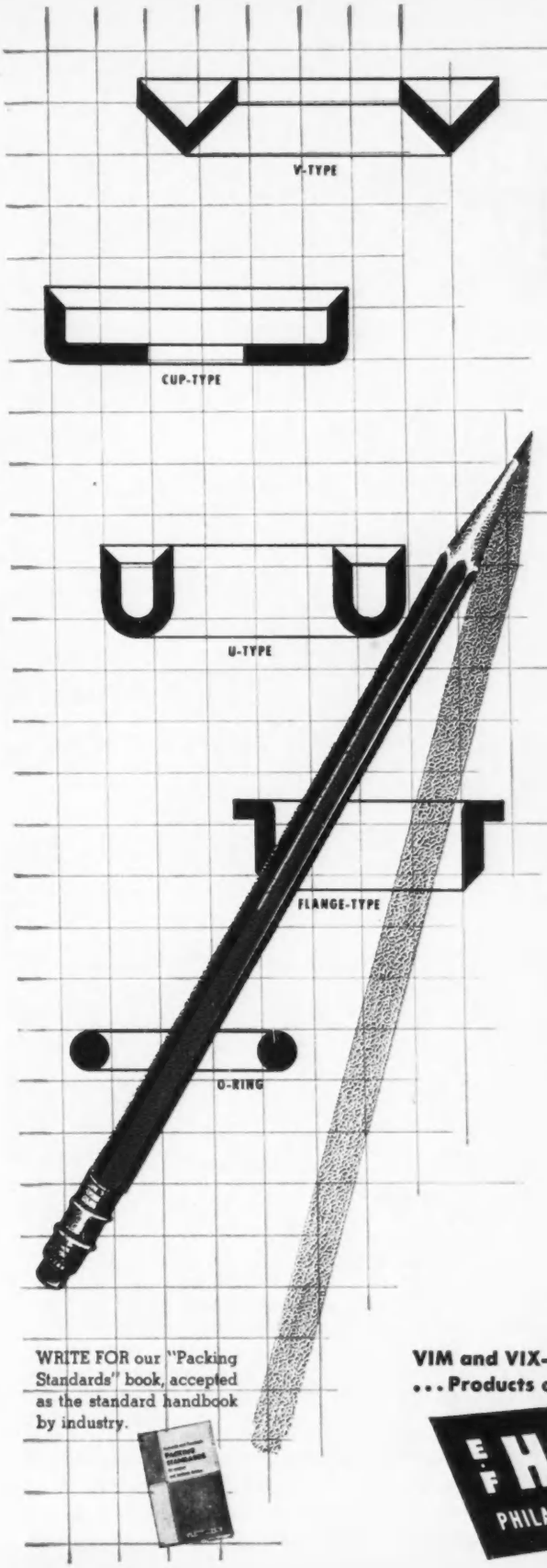
SIMMONDS Products, Inc.
AEROCESSORIES, INC.
TARRYTOWN, NEW YORK

Branch Offices: Glendale, Calif. • Dayton, Ohio
Dallas, Texas • Washington, D.C. • Montreal, Canada

"an unusual and outstanding product."*

** "I have just leafed through your new ANNUAL HANDBOOK OF PRODUCT DESIGN FOR 1953 . . . I find it to be an unusual and outstanding product. The writer plans to study it and pass it along to our top executives for review."*

President
Powdered Metal Parts
Manufacturer



Check HOUGHTON FIRST for Hydraulic and Pneumatic PACKINGS

VIM
LEATHER PACKINGS

cup, flange, U and V types—flat washers, discs and gaskets—for oil, air, water or gas applications—used for all pressures and for temperatures up to 200° F.

VIX-SYN SYNTHETIC
RUBBER PACKINGS

including homogeneous and fabricated packings, gaskets and adaptors—also O-rings and "Vim" leather back-up washers designed for use with them.

To meet your hydraulic and pneumatic packing needs . . .

HOUGHTON HAS THEM ALL!

WRITE FOR our "Packing Standards" book, accepted as the standard handbook by industry.

VIM and VIX-SYN PACKINGS
. . . Products of

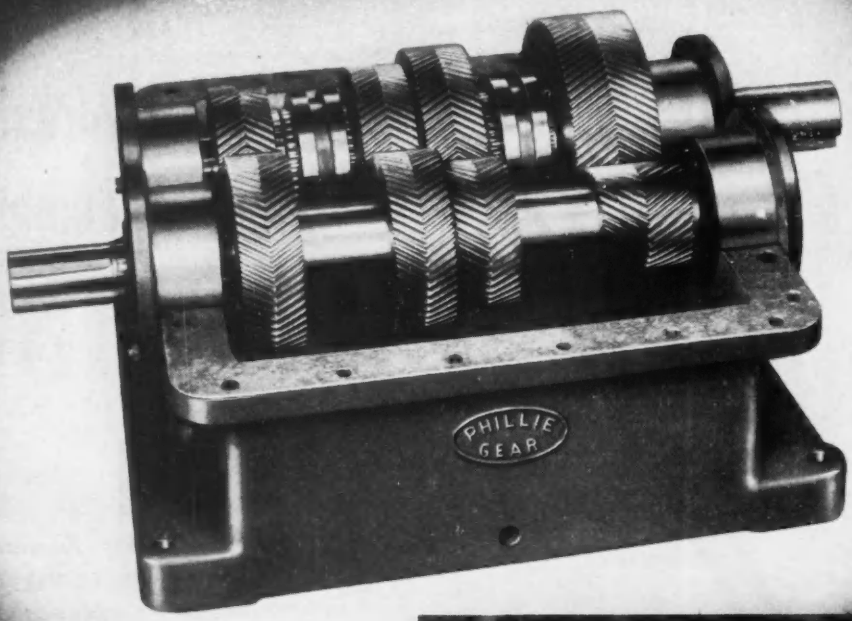
E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

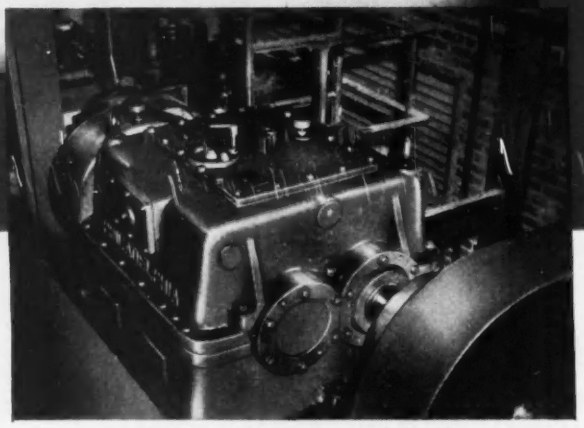
PACKING AD #1-53

STANDARDIZED CONSTRUCTION

...to give you Greatest Economy



Philadelphia
CHANGE-SPEED UNITS



Based on long experience in building Change-Speed Units to individual specifications, Philadelphia has developed a line of *standardized* units. This cuts the high cost and delayed deliveries of former methods.

Units are positive geared drives using herringbone gears throughout. No belts to wear or slip. Ratios are definite for speed increasing or reduction or in combination. Wide range of horsepowers in 2, 3 and 4 speed units.

Write for catalog giving full details.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

FORD POWER helps digger make Bigger Profits!

6 GREAT HEAVY-DUTY ENGINES NOW AVAILABLE IN THE POPULAR INDUSTRIAL POWER RANGES

● There's a quick solution to the problem of powering equipment designed for construction work, mining, logging, agriculture or any one of a thousand industrial tasks. *Specify a Ford Heavy-Duty Industrial Engine!*

Ford builds engines ranging from 120 to 317 cu. in. displacement . . . 4-cyl., 6-cyl., and V-8 types. They are designed for rugged industrial jobs and built to Ford-famed high-precision standards for long life and economical maintenance.

What's more, wherever your equipment is put to work, there's always a Ford Dealer nearby who carries the more commonly purchased replacement parts and, if necessary, trained mechanics for quicker service. In fact, the fast-growing popularity of Ford Industrial Power is based on three important factors: 1. RIGHT POWER, 2. RIGHT FEATURES, 3. RIGHT SERVICE. Our experienced Sales Engineers are ready to cooperate in any development problems involving the best use of Ford Industrial Power.

Specify Ford because . . .

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED!

Quick, efficient drilling of foundation holes for towers and poles, of wells for irrigation, etc., grows increasingly essential to industry and agriculture. Here you see a modern Earth Auger at work. This is a product of H. B. Williams Mfg. Co., Dallas, Texas. Mounted on a turntable at the rear of a Ford F-7 Truck, the auger is powered by twin Ford V-8 Heavy-Duty Industrial Power Units which make light of this task.

CLIP AND MAIL COUPON TODAY!

INDUSTRIAL ENGINE DEPARTMENT
FORD MOTOR COMPANY
15050 Woodward Ave., Highland Park 3, Mich.

We are interested in Industrial Power for:

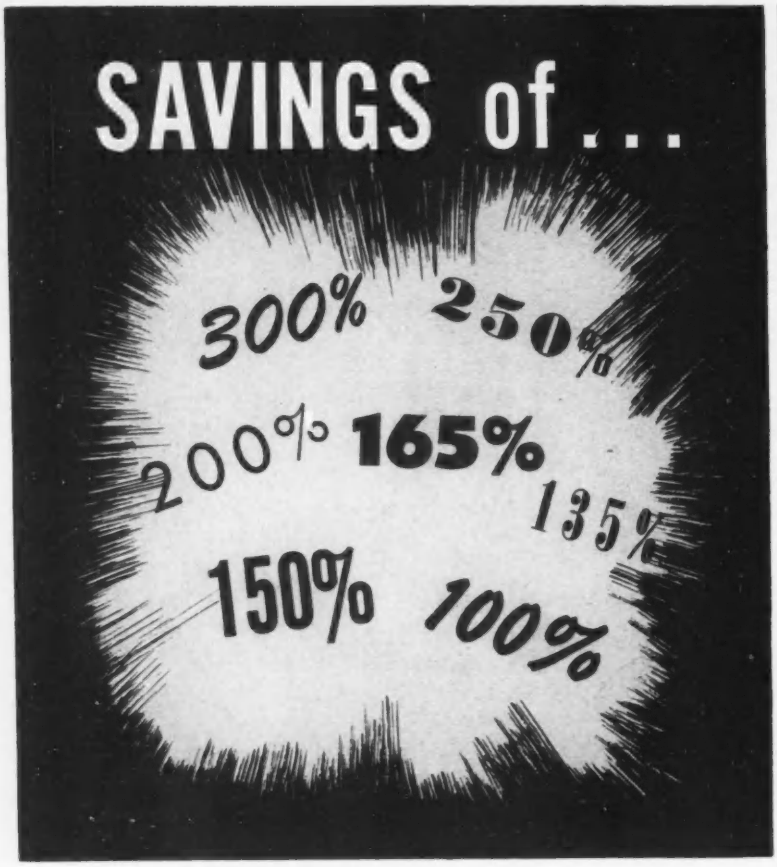
_____
(state your application)

Send us 1952 literature on Ford Industrial Engines checked below:

☐ "120" 4-cyl. ☐ "215" 6-cyl. ☐ "239" V-8
☐ "254" 6-cyl. ☐ "279" V-8 ☐ "317" V-8
"MULTA-TORQUE" Converter

Firm Name _____
(please print)
Street _____
City _____ Zone ____ State _____ B

SAVINGS of...



Some customers tell us they have saved as high as 300% on machining costs by using Hitchiner Precision Investment Castings. Such large savings are exceptional . . . BUT savings up to 150% in the price of hundreds of complex metal parts are becoming quite usual.

An understanding of the enormous possibilities of investment castings together with effective designing of metal parts make tremendous savings possible. Ask our representative to call and discuss your problem or send us drawings and specifications for complete engineering analysis and recommendation without obligation.

In any case send for this informative folder on Hitchiner Precision Investment Castings

AT THE METAL EXPOSITION
SEE US AT BOOTH 817

HITCHINER Manufacturing Company, Inc.
MILFORD 4, NEW HAMPSHIRE
Representatives in principal cities.

How to keep informed on the "with what" part of your business

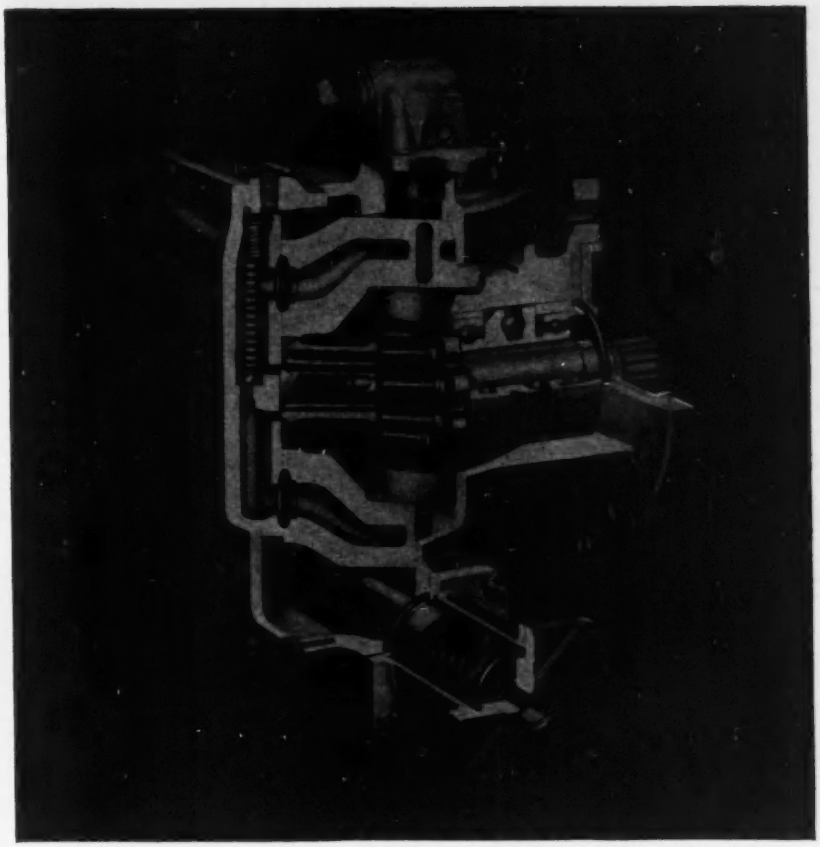
AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information—advertising. You might call it the "with what" type—which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better—save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS



Cutaway view showing O-rings. Illustration courtesy Vickers, Inc.

PARKER O-RINGS help pumps set endurance record

Vickers reversible flow 3,000 PSI hydraulic pumps, equipped with PARKER O-rings, recently operated 304,578 pump hours without malfunction for a 12-month period at one airline.

This noteworthy performance—in all sorts of weather—demonstrates the leakproof, long service qualities of PARKER O-rings . . . precision-molded from superior synthetic rubber compounds. Important, too, they provide simplified as well as efficient sealing. Design involves only a small groove to retain the ring. They are economical to use, easy to replace.

PARKER is the one source for *all* standard O-rings for fuel, hydraulic and engine oil services, and for special service O-rings. Ask your PARKER Distributor for Catalog 5100, or write The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

THIS IS IT

Cross section drawing of O-ring in groove, sealing under pressure.

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker O-RINGS

ARE STOCKED BY THESE AUTHORIZED DISTRIBUTORS

AKRON, O.
B. W. Rogers Co.
850 So. High St. (9)

BOSTON, Mass.
Irving B. Moore Corp.
65 High Street

BUFFALO, N. Y.
Hercules Gasket & Rubber Co.
327 Washington St. (3)

CHICAGO, Ill.
Air Associates, Inc.
5315 W. 63rd St. (38)
Shields Rubber Co.
564 W. Randolph St. (6)

CLEVELAND, O.
Cleveland Ball Bearing Co.
3865 Carnegie Ave. (3)
Neff-Perkins Co.
2130 St. Clair Ave. (14)

DALLAS, Tex.
Air Associates, Inc.
3214 Love Field Dr. (9)
Metal Goods Corp.
6211 Cedar Springs Rd. (9)

DENVER, Colo.
Metal Goods Corp.
2425 Walnut St.

DETROIT, Mich.
J. N. Fauver Co.
49 West Hancock St. (1)

FORT WORTH, Tex.
Adco Industries
3414 Camp Bowie Blvd.

HOUSTON, Tex.
Metal Goods Corp.
711 Milby St. (1)

INDIANAPOLIS, Ind.
F. H. Langsenkamp Co.
229 E. South St.

KANSAS CITY, Mo.
Metal Goods Corp.
1300 Burlington Ave. (16)

LOS ANGELES, Cal.
Aero Bolt & Screw Co., Inc.
1071 Arbor Vitae Ave.
Inglewood, Calif.
Synthetic Rubber Products Co.
1538 South Eastern Ave. (22)

MIAMI, Fla.
Air Associates, Inc.
International Airport

MILWAUKEE, Wis.
Allrubber Products & Supply Co.
612 So. Second St. (4)

MINNEAPOLIS, Minn.
Van Dusen Aircraft Supplies, Inc.
2004 Lyndale Ave., South (5)

NEW ORLEANS, La.
Metal Goods Corp.
432 Julia St. (12)

NEW YORK, N. Y.
Durham Aircraft Service Co.
5615 Northern Blvd., Woodside, N. Y.
Nielsen Hydraulic Equipment, Inc.
298 Lafayette St. (12)

PHILADELPHIA, Pa.
Goodyear Supply Co.
1506 Latimer St.

PITTSBURGH, Pa.
Shields Rubber Co.
137 Water St. (22)

PORTLAND, Ore.
Hydraulic Power Equipment Co.
2316 N. W. Savier St. (10)

ST. LOUIS, Mo.
Metal Goods Corp.
5239 Brown Ave. (15)

TULSA, Okla.
Metal Goods Corp.
302 North Boston (3)

WICHITA, Kans.
Standard Products, Inc.
650 E. Gilbert (11)

CANADA
Railway & Power Engineering Corp., Ltd.
3745 St. James St.

This is a dragline double roller track bracket; weight 213 lbs. Originally produced as a weldment, the part was redesigned to a steel casting through cooperation of the steel foundry and manufacturer's engineering department.

In addition to the 35% savings, adoption of steel castings resulted in (1) a more readily machined part, due to decreased machine stock allowance and a uniform amount of stock (2) elimination of "creep" after machining, a condition caused in the fabrication by internal stresses (3) better appearance —always desirable when parts are visible in the final assembly.

* * *

Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

50 YEARS OF SERVICE TO INDUSTRY

STEEL FOUNDERS' SOCIETY OF AMERICA

920 Midland Building — Cleveland 15, Ohio

Design and Build With Steel Castings

Brand New
40-PAGE
SPAULDING HANDBOOK

Send for Your FREE COPY

Spaulding
PRODUCTS
for
INDUSTRY
THE ANSWER TO INDUSTRY'S PROBLEMS
VULCANIZED FIBRE:
in sheets, rods, tubes and fabricated parts.
ARMITE:
Thin insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.
SPAULDITE:
(Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.
SPAULDO:
Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.
SPAULDING FIBRE BOARD:
in sheets and fabricated parts.
SPAULDING T BOARD:
A superior Transformer Board, in sheets and fabricated parts.
MATERIAL HANDLING EQUIPMENT:
Factory trucks, Boxes, Barrels, Trays, etc.
Our Factories and Branch Sales Offices are shown on inside front cover.
SPAULDING FIBRE COMPANY, Inc.

AN IDEA BOOK, buying guide and technical manual rolled into one. Especially valuable as a reference work for Design Engineers, Draftsmen and Buyers of machine parts.

Includes...

- Tables of Physical Properties
- Charts for determining dimensional changes
- List of applications classified by industries
- Illustrations and descriptions of typical applications classified as to combinations of properties
- Forming and Fabricating information
- Hints to Engineers and Draftsmen
- Grade selection charts
- ...and a wealth of other useful information.

SPAULDING
BRANCH SALES OFFICES

BOSTON 16, MASS.
585 Boylston St.

BRIDGEPORT 5, CONN.
2889 Fairfield Ave.

CHICAGO 25, ILL.
4770 Lincoln Ave.

CHICAGO 38, ILL.
5604 West 63rd St.

CLEVELAND 14, OHIO
2108 Payne Ave.

CLEVELAND 16, OHIO
19035 Detroit Rd.
Rocky River

DAYTON 2, OHIO
136 South Ludlow St.

DETROIT 1, MICH.
4612 Woodward Ave.

FORT WAYNE 6, IND.
2301 Fairfield Ave.

LANSING 10, MICH.
2021 South Cedar St.

LONG ISLAND, N. Y.
90-34 Jamaica Ave.
Woodhaven 21, L. I., N. Y.

MILWAUKEE 8, WIS.
3329 West Vliet St.

NEW YORK 55, N. Y.
384 East 149th St.

NEWARK 2, N. J.
965 Broad St.

PHILADELPHIA, PA.
702 Federal St.
Camden 3, N. J.

ST. LOUIS 5, MO.
34 North Brentwood Blvd.

TONAWANDA, N. Y.
310 Wheeler St.

LOS ANGELES 5, CALIF.
C. D. LaMoree
1325 San Julian St.

BERKELEY 10, CALIF.
C. D. LaMoree
2221 Fourth St.

TORONTO 18, ONT., CANADA
H. A. Anderson & Co.
28 Jackson Ave.

Mail *Coupon* Below to
Spaulding FIBRE COMPANY, INC.
TONAWANDA, N. Y.

SPAULDING FIBRE CO., INC.
TONAWANDA, NEW YORK

Please send me by return mail my free copy of your new 40-page Handbook.

Name_____

Title_____

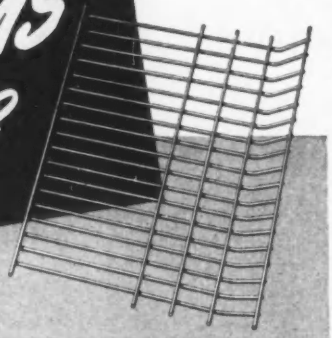
Firm Name_____

Address_____

City_____ Zone____ State_____

PE

Any of these PROBLEMS Like Yours?



Had to Conserve Steel

Ice deflector assembly made by Company A for ice cube machines consisted of sheet steel, woven wire cloth and steel frame. Material shortages loomed. Told it to Titchener. Titchener designed this welded wire rack using one size of wire. New assembly proved to be sturdier — rustless — lower in cost. Additional dividends: simple tooling — fast large-scale production.

Note: Wire is more readily available during shortages. Can your product be made of wire? Ask Titchener.

Wanted Substitute for Casting

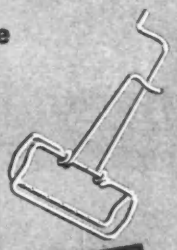
Company B, a stove manufacturer, was dissatisfied with breakage of its cast iron burner grates. Told it to Titchener. This Titchener welded-wire assembly was substituted. Result: No breakage — costs less.

Note: Wire is rigid, yet resilient. Light, yet tough. Stronger than castings or forgings. Wondering if wire can help you? Ask Titchener.

Design Was Difficult to Produce

Company C designed this complicated two-piece floor mop wire clamp. Ran into production difficulties. Told it to Titchener. Our skilled tool makers developed an ingenious method of coiling wire around itself. This made it possible to produce thousands of precision-made clamps at high speed on Titchener's forming machines.

Note: Titchener has worked hand in glove with all types of industry — large and small — in peace and war — for 65 years. How can Titchener serve you?



Tell it to TITCHENER!

If your problem involves wire forms, light stampings, welded-wire assemblies or wire-and-strip-steel items — Tell it to Titchener.

Titchener offers you . . .

- Design Assistance
- Tool and Jig Making
- High Volume Production
- Plating and Finishing
- Sample Making
- Quickly Available Materials
- Careful Inspection
- Prompt Delivery

Send us your prints — or describe your problem in a letter. Confidential. No charge for our suggestions.

E. H. TITCHENER & CO.

103 CLINTON ST. BINGHAMTON, N.Y.

McGRAW-HILL

TECHNICAL WRITING SERVICE

Writing

Whether you need an instruction book or service manual to accompany your equipment written to government specifications . . . or product catalogs . . . or training booklets . . . or industrial literature . . . our writing staff can do the job for you. It will do the research, planning, writing, and organizing to satisfy your requirements.

Illustrating

For government publications or industrial literature, our Art department can meet your specifications, or those of the government agency, for isometrics, exploded views, cutaway views, retouched halftone copy, rendering, lettering, or any other type of art work. It can design to standardized format or present industrial visuals of compelling appeal.

Editing

The editors of our staff are thoroughly familiar with government publication specifications. In addition to being technical editors, they are also experienced in rewriting and organizing rough manuscript, or in revising published material. Many have taught or have been trained in teaching and are, therefore, able to recommend or inject proper pedagogical presentation of material.

Printing

Our printing, binding, and paper resources are among the best in the country. Every type of reproduction is available . . . offset, letterpress, multigraph, or even mimeograph. We can handle a complete printing job or, in the case of offset, furnish repro copy when other facilities must be used.

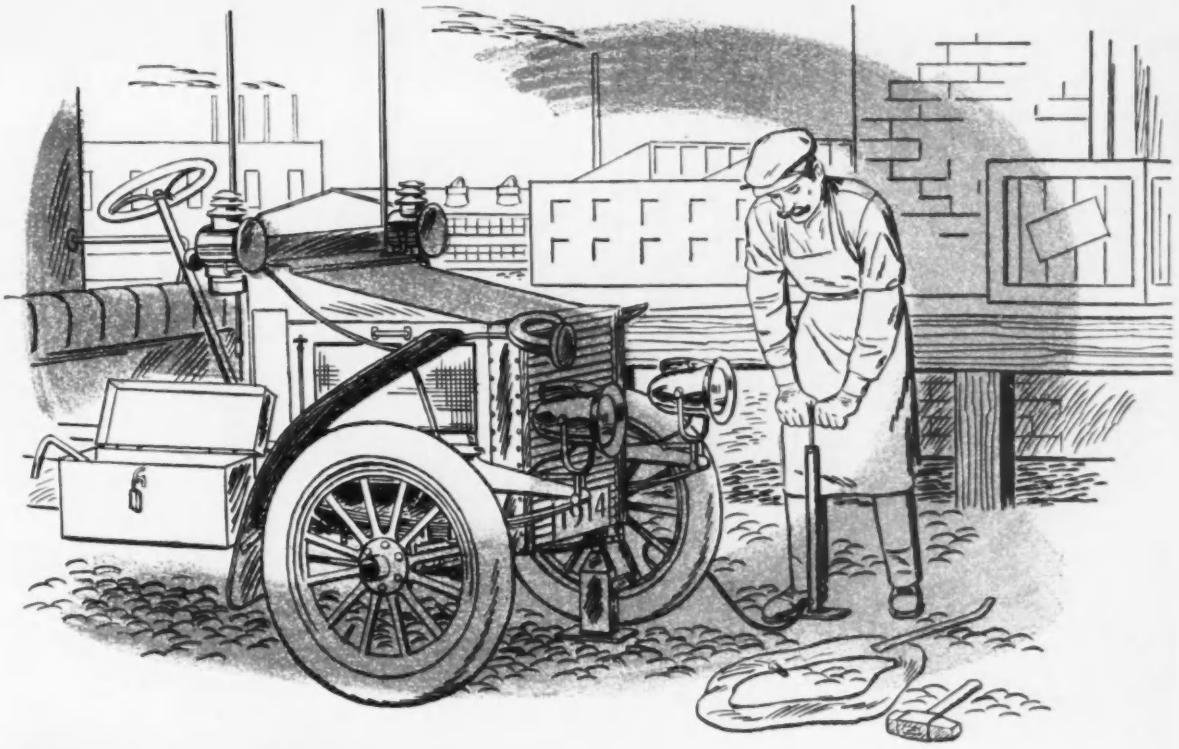
Save money and time . . . let our staff be your staff for technical publications. Write for our brochure or ask our representative to call.

Technical Writing Service

McGRAW-HILL BOOK CO., INC.

330 West 42 Street

New York 36, N. Y.



Motor Power...

eliminated the need for this back-bending labor!

Compressed air, used in numerous industrial applications to lift, move, clean and spray, also provides the riding cushion for millions of vehicles.

Powerful, efficient compressors, equipped with specially adapted motors, make this commodity an important and useful tool for industry. Car-owning families are patrons of "free-air" service, made available through America's 190,000 filling stations, thanks to that same number of dependable air compressors.

Emerson-Electric Motors were first used on air compressors in 1899, and the progress of the industry has been matched with improvements in the motor drives.

Emerson-Electric builds dependable, efficient motors for equipment used in industry, in business, on the farm and in the home. There is a complete line of Emerson-Electric standard motors in horsepower ratings from 1/20 to 5, and hermetic motor parts in ratings from 1/8 to 15 horsepower. Your inquiry is invited.

The EMERSON ELECTRIC Mfg. Co., St. Louis 21, Mo.

MODERN INDUSTRY **IS POWERED WITH** ELECTRIC MOTORS

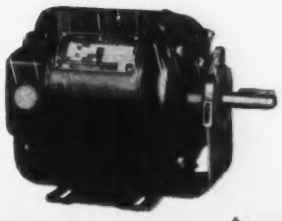
EMERSON-ELECTRIC'S unique

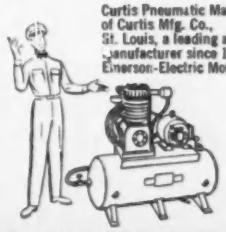
Twingineering

SERVICE

solves your power problems

Our engineers are eager to work with yours in designing and providing the correct motor for contemplated new or improved appliances or equipment. "TWIN-GINEERING" saves costly engineering "back-tracking," and may suggest short cuts and product improvement. Write today for Bulletin No. M180.





Curtis Pneumatic Mach'y Div. of Curtis Mfg. Co., St. Louis, a leading air compressor manufacturer since 1896, is a user of Emerson-Electric Motors.

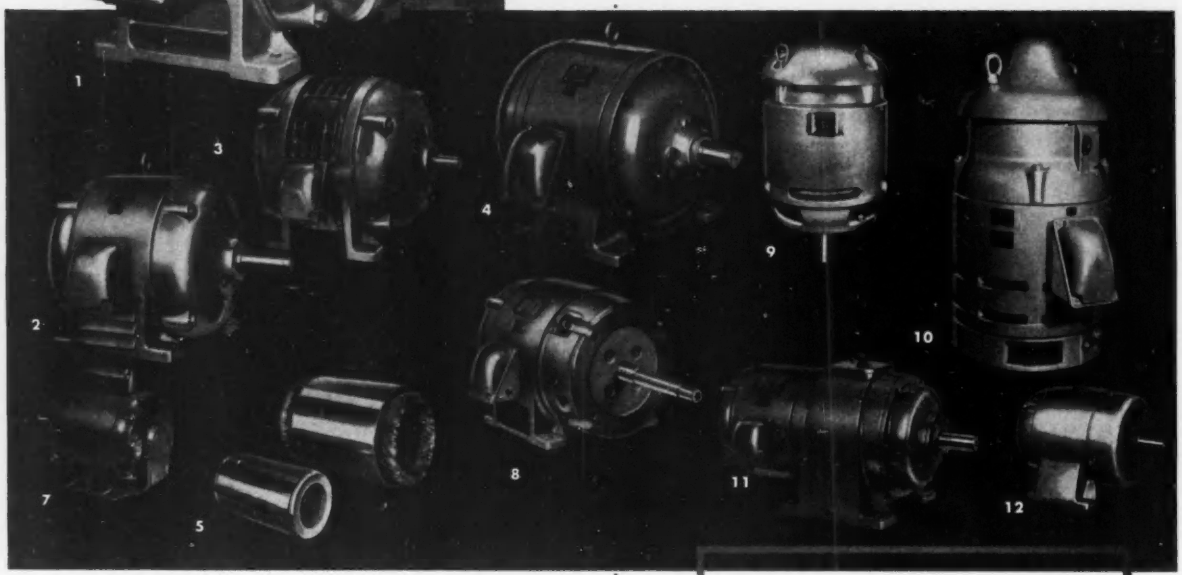
EMERSON ELECTRIC

MOTORS • FANS — APPLIANCES

LEADERS IN THE MOTOR AND FAN INDUSTRY SINCE 1890

Quality MOTORS IN Quantity

For Nearly Every Purpose



Mechanical Types: Drip-proof (1); Splash-proof (2); Totally Enclosed Non-Ventilated (3); Totally Enclosed Fan-Cooled (4); Rotors and Stators (5); Rigid Base (6); Resilient Base (7); Flanged (8); Vertical Solid Shaft (9); Vertical Hollow Shaft (10); Gear Motor (11); Special Purpose (12).

Electrical Types: Fractional H.P. ¼ to ¾. Integral H.P. 1 through 500. Single phase. Polyphase. Normal Slip. High Slip. Normal Torque. High Torque.

A. O. SMITH offers you quality motors in a wide range of types and sizes from ⅓ H.P. to 500 H.P. Proof of quality is demonstrated daily by hundreds of thousands of units which furnish power for all kinds of useful work. Service throughout the nation is provided by hundreds of Authorized A. O. Smith Motor Service Stations. Write today for information on standard or special types. A. O. Smith Corporation, Electric Motor Division, 5715 SMITHway St., Los Angeles 22, Calif.

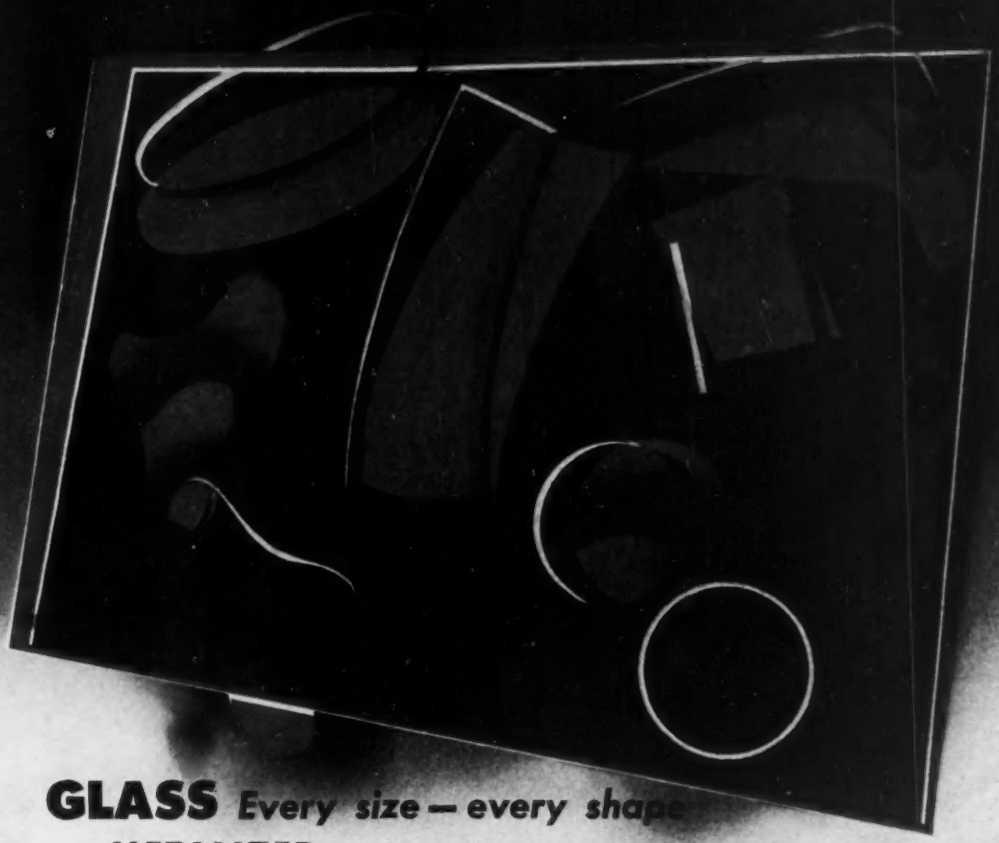
A.O.Smith

ELECTRIC MOTOR DIVISION

FACTORIES: 5715 SMITHWAY ST., LOS ANGELES 22, CALIF. • 1000 WEBSTER ST., DAYTON 4, OHIO

Offices in Principal Cities. International Division, Milwaukee 1

DEARBORN knows how...
to economically convert flat GLASS
FOR PRODUCT APPLICATION



GLASS *Every size — every shape*

METALIZED

TEMPERED · GLAREPROOF

SHOCKPROOF · HEAT RESISTANT

Concave	Squares
Convex	Odd shapes
Bent	Beveled
Flat	Drilled
Circles	Machined
Ovals	Decorated

COLOR is a DEARBORN Specialty...
- CERAMIC FIRED
- BAKED
- CLEAR ORGANIC

REQUEST HERE FOR MORE INFORMATION

DEARBORN Glass Company

2400-44 W. 21st STREET CHICAGO 8, ILLINOIS

Gentlemen:

Your facilities for processing flat glass are of interest to us. Please send more information on your capacity for handling my special requirements for glass on the following products.

_____

_____

_____

☐ My blue print and specifications are attached. Please send information marked for my personal attention.

My name is _____

Company name _____

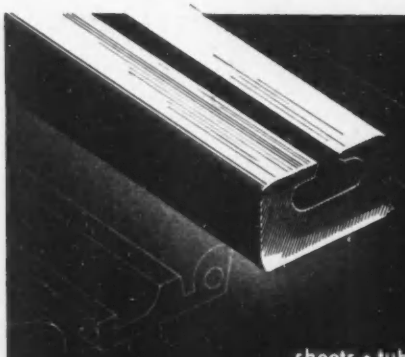
Address _____

City and state _____

DEARBORN GLASS CO. PLANTS AT CHICAGO, ILL. AND JERMYN, PA.

Acadia Synthetic Rubber Products are once again in great demand for the nation's defense. They are serving in a large variety of important purposes in weapons and equipment on land, sea and in the air. Manufacturers in hundreds of industries have learned they can always depend upon the uniformly high quality of Acadia Synthetic Rubbers.

They are readily compounded to exact degrees of elasticity, resilience, plasticity: offer high resistance to oil, age, light, temperature extremes. They can be molded or extruded—cut to close tolerances in endless shapes and sizes.



sheets • tubing • strips
• channel • washers •
seals • bellows •
gaskets • rings •
extrusions • cut parts

ACADIA Synthetic PRODUCTS

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions • Molded Parts

DIVISION WESTERN FELT WORKS
4035-4117 Ogden Avenue, Chicago 23, Illinois

*"qualifies for a textbook ranking."**

Hundreds of *Product Engineering* subscribers have written letters to tell us how much the ANNUAL HANDBOOK OF PRODUCT DESIGN FOR 1953 is helping them.

It can help *you* every day . . . by providing the best design data available on a wide variety of subjects. Get your copy out now, and see if you don't agree with *this* reader's appraisal of it:

* *"The ANNUAL HANDBOOK OF PRODUCT DESIGN FOR 1953 is outstandingly good and qualifies for a textbook ranking. First perusal started several inquiries to suppliers which can result in considerable business for them, and advantages for us."*

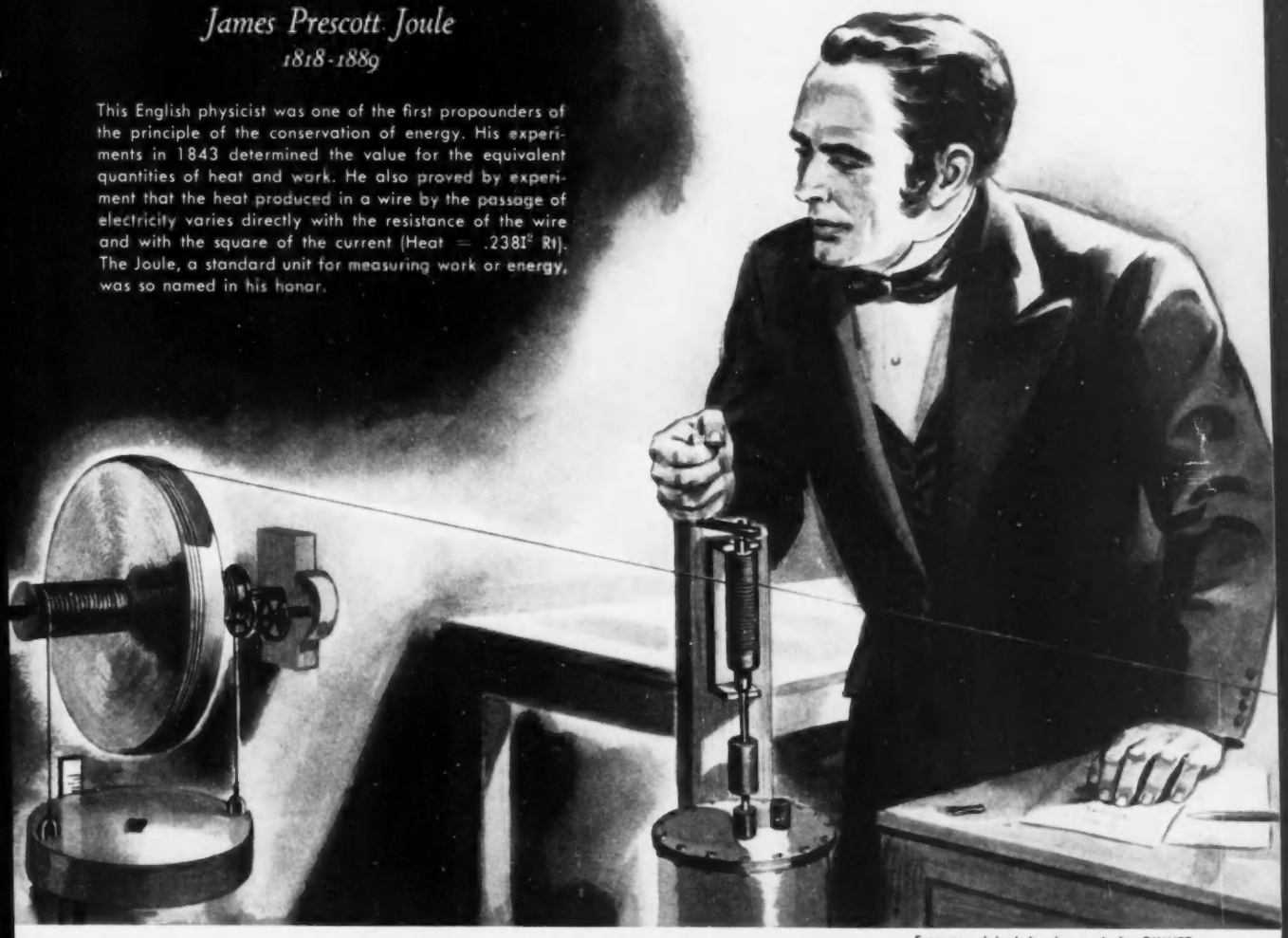
President
Freezer Manufacturer

JOULE

...FIRST to accurately determine the mechanical and electrical equivalent of heat

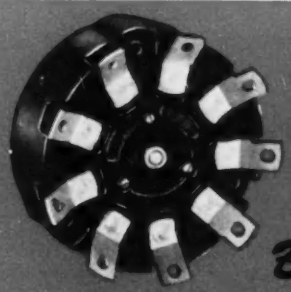
James Prescott Joule
1818-1889

This English physicist was one of the first propounders of the principle of the conservation of energy. His experiments in 1843 determined the value for the equivalent quantities of heat and work. He also proved by experiment that the heat produced in a wire by the passage of electricity varies directly with the resistance of the wire and with the square of the current (Heat = $.238I^2$ Rt). The Joule, a standard unit for measuring work or energy, was so named in his honor.



From an original drawing made for OHMITE.

OHMITE®..FIRST in Tap Switches *today*



OHMITE all-ceramic power type tap switches are preferred by industry over all other makes on the market. Their compactness, permanent ceramic and metal construction, and proven ability to give years of dependable, trouble-free service . . . make them ideal for the toughest applications.

Specify OHMITE when you want the best!

Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE®

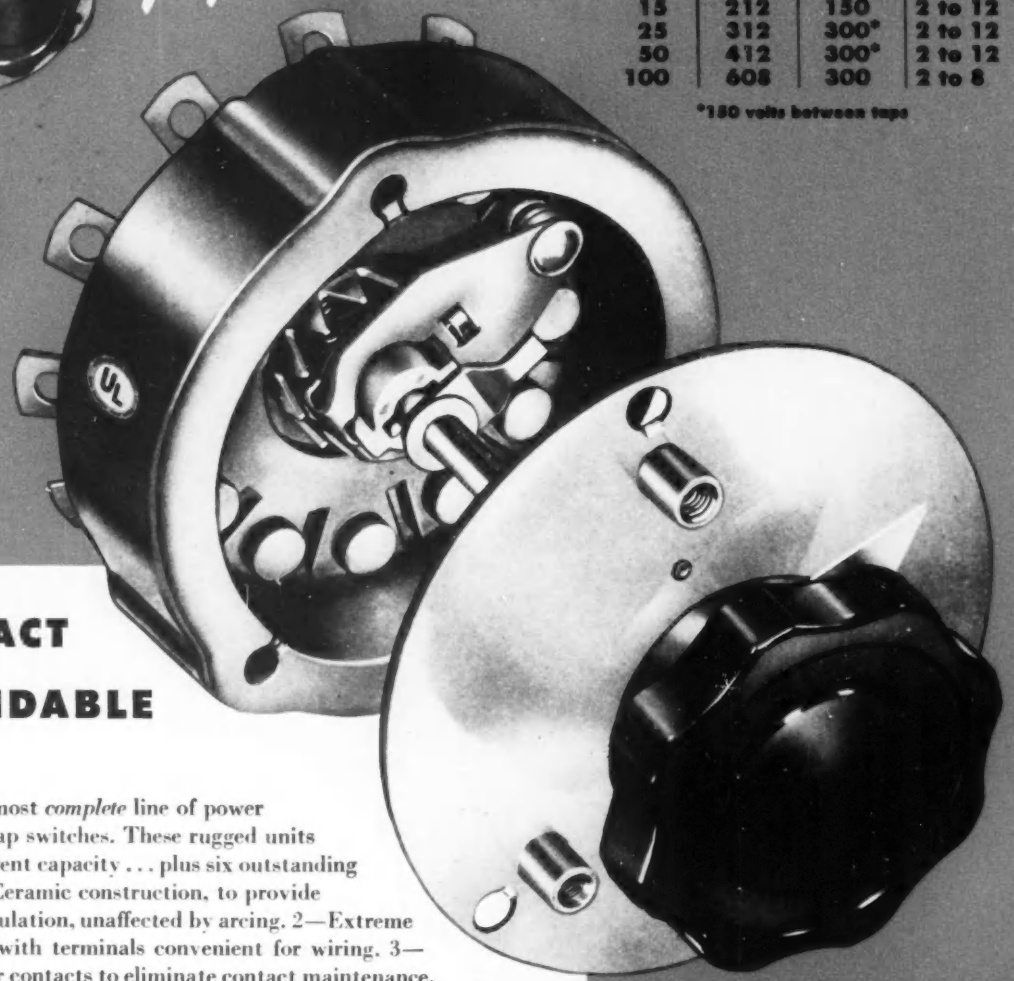
ALL-CERAMIC • POWER TYPE

Tap Switches

FIVE SIZES

AMPS.	MODEL No.	MAX. V. (A-C)	No. TAPS
10	111	150	2 to 11
15	212	150	2 to 12
25	312	300*	2 to 12
50	412	300*	2 to 12
100	608	300	2 to 8

*150 volts between taps



COMPACT
DEPENDABLE

Here's the most *complete* line of power type, rotary tap switches. These rugged units have high current capacity . . . plus six outstanding features! 1—Ceramic construction, to provide permanent insulation, unaffected by arcing. 2—Extreme compactness, with terminals convenient for wiring. 3—Silver-to-silver contacts to eliminate contact maintenance. 4—Self-cleaning rotor contact. 5—"Slow-break" mechanism, with positive cam-and-roller for "slow-break, quick-make" action for A-C. 6—"Dead" switch shaft, insulated by strong ceramic hub.

OHMITE MANUFACTURING COMPANY
4819 Flournoy Street
Chicago 44, Illinois

Write on company letterhead for this comprehensive OHMITE catalog

Be Right with **OHMITE** **RHEOSTATS • RESISTORS • TAP SWITCHES**

HERE'S WHAT HAPPENS TO A JOHNSON UNIVERSAL BRONZE BAR

Every Application Saves Time and Money!

IN ADDITION to the common uses, bushings, bearings, washers and thrust plates, certain manufacturers are making bronze gears, sheaves, trolley wheels, rollers, guide rolls, air tool tips, etc., from Johnson Universal Bronze. There are reasons for wider use of this material: ease of machining, corrosion resistance, non-sparking properties, long life, less frequent replacement . . . to mention a few.

Johnson Universal Bronze is available from distributors' stocks in over 400 sizes. Round bars, solid or cored, are completely machined, OD, ID and ends, and are usable from end to end . . . no waste. Hexagon bars, not machined, are made in a range of sizes, too. Investigate the possibilities of using Universal Bronze for special applications in your industry. Write for catalog, showing sizes available.

JOHNSON BRONZE COMPANY
508 South Mill St., New Castle, Pa.

Over **400** Sizes
Stocked by your local JOHNSON *distributor*

JOHNSON B BEARINGS
Sleeve-Type
Sleeve Bearing Headquarters Since 1901

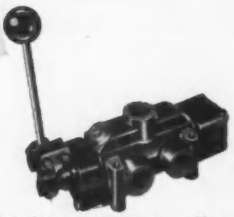
ADEL *Industrial Hydraulic Equipment*

for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS

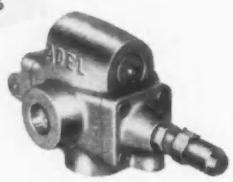
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



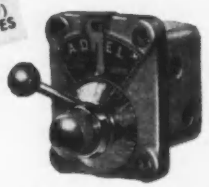
4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES



Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

VOLUME (FLOW) CONTROL VALVES



Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES

2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES

Valves allow free flow in one direction only. Many variations available. 3000 psi.

A FEW SELECT TERRITORIES ARE STILL AVAILABLE TO PROGRESSIVE DISTRIBUTORS OF HYDRAULIC EQUIPMENT. INQUIRIES INVITED.

For complete engineering specifications and counsel, Address: ADEL DIVISION—GENERAL METALS CORPORATION, 10767 Van Owen Street, Burbank, California.

ADEL LEADER IN HYDRAULICS

DIVISION OF GENERAL ...RPORATION • Burbank, Calif.

Manufacturers of Industrial Hydraulic Valves and Pumps

DISTRIBUTORS: AIR & HYDRAULIC ENGINEERING CO., NEW HAVEN, CONN. • RUSS CHAMBERLIN COMPANY, PORTLAND, OREGON • J. BOYD COATES, PHILADELPHIA, PA. • FRANK T. DONNELLY COMPANY, PITTSBURGH, PA. HASKEL ENGINEERING & SUPPLY CO., SAN FRANCISCO, CALIF. • HASKEL ENGINEERING & SUPPLY CO., GLENDALE, CALIF. • HYDRAULIC BRAKE SUPPLY CO., PHOENIX, ARIZ. • LINCOLN SUPPLY CO., PROVIDENCE, R. I. • SCOTT EQUIPMENT AND ENGINEERING COMPANY, DAYTON, OHIO • H. F. SODERLING CO., SEATTLE, WASH. • ROBERT TAYLOR & SONS, SALT LAKE CITY, UTAH • WYATT SALES COMPANY, CLEVELAND, OHIO • CORBY SUPPLY COMPANY, ST. LOUIS, MO. • INDUSTRAIL AIR & HYDRAULIC EQUIPMENT CO., DETROIT, MICH.

7 Years of Outstanding Service Reported for Slo-Speed

Slo-Speeds have given outstanding service on casting tumblers which place rapidly alternating and opposing heavy loads on the gears. Slo-Speeds also operate in the presence of fine sand and iron dust and in spite of this unusual abuse, Slo-Speeds have been in operation 5 days per week since 1944 with no attention except lubrication, reports H. L. Romine, Foundry Engineer, Renfrow Gray Iron Foundry, Los Angeles.

STERLING SLO-SPEED

GIVES YOU THE ONE BEST LOW SPEED AND

gives uninterrupted service — carries heavy overhung loads — provides versatile mounting and flexibility in arrangement of machinery — saves valuable space — provides greater safety — costs less to install and use. An indispensable source of low speed power for:

Agitators	**Dryers**	**Presses**
Blenders	**Feeders**	**Pumps**
Blowers	**Kilns**	**Screens**
Conveyors	**Mills**	**Tumblers**
Cookers	**Mixers**	**Etc., etc.**

20-page illustrated catalog... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for-catalog No. C-431

STERLING ELECTRIC MOTORS

Plants: New York City 51; Van Wert, Ohio; Los Angeles 22; Hamilton, Canada; Santiago, Chile Offices and distributors in all principal cities

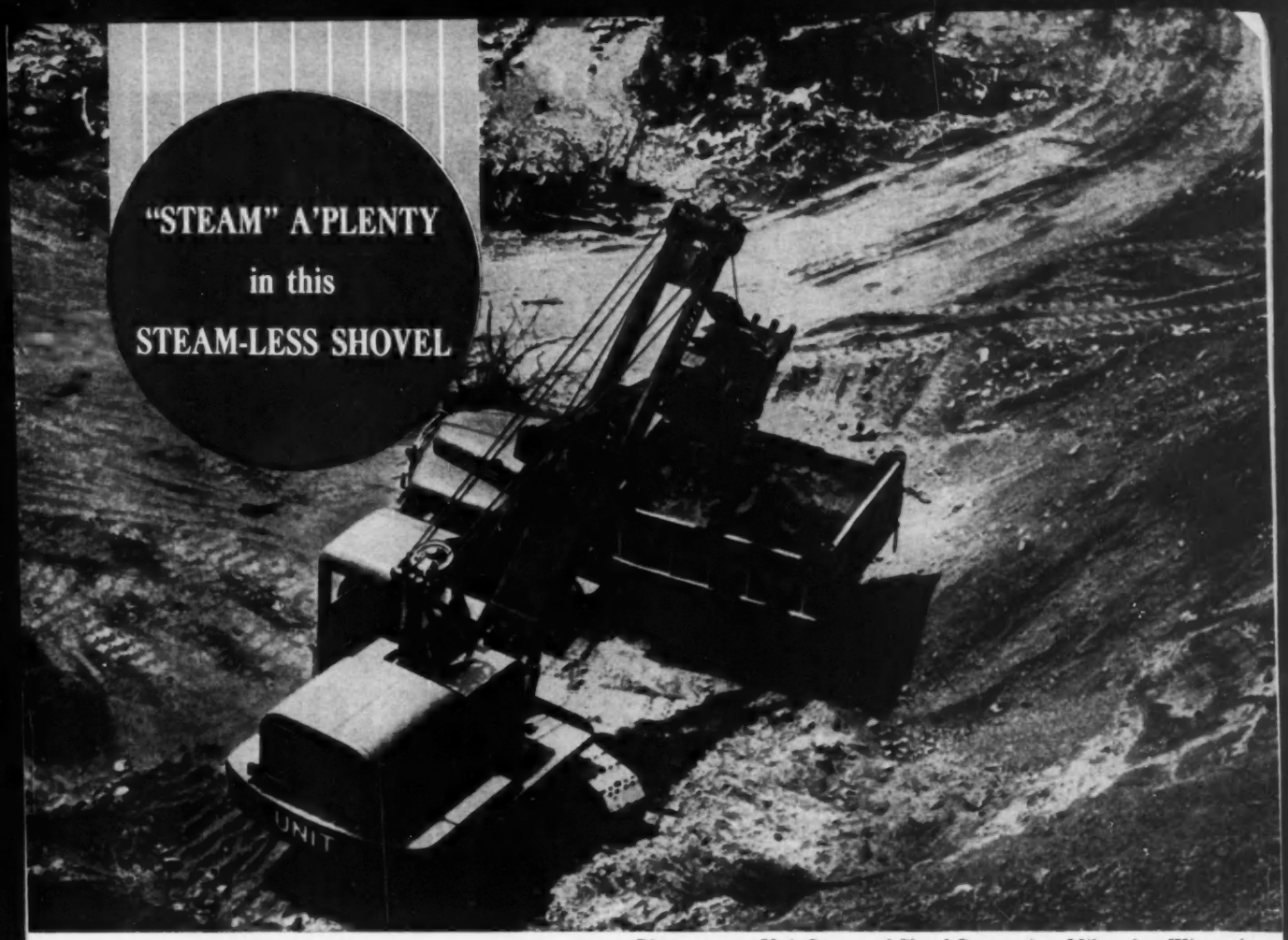
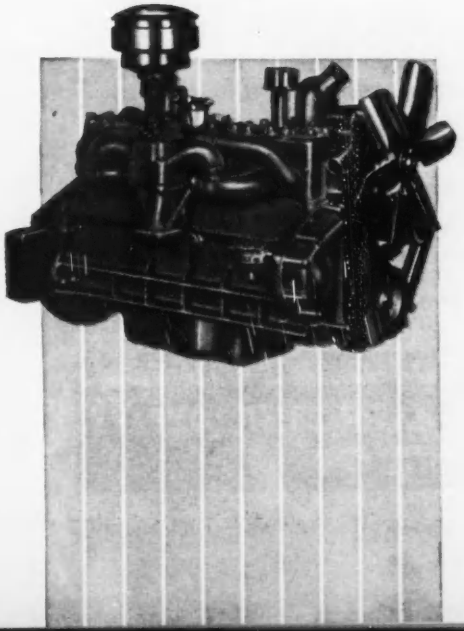


Photo courtesy Unit Crane and Shovel Corporation, Milwaukee, Wisconsin

...more work at less cost with Chrysler power and Chrysler torque converter



Today, all over the country, gasoline-powered versions of the old steam shovel are piling up record after record for volume output, speed and economy of operation.

In the vanguard of modern earth-moving equipment is Unit's model 614 one-half yard shovel, powered by the Chrysler Model 16 Industrial Engine and featuring the Chrysler torque converter as standard equipment. Unit operators find this an ideal combination since, in giving them fast, dependable power without risk of stalling, work output is *increased* while fuel consumption is actually *decreased*. Moreover, the smooth application of power through the torque converter eliminates shock loads to engine and equipment, thereby reducing maintenance costs.

This is but another example of how Chrysler is meeting the many and varied requirements for industrial power. For example, Chrysler can supply manufacturers with a corrosion-resistant or fungus-treated electrical system, a propane or natural gas-burning carburetor, three, four or five-speed transmission, standard or gyrol Fluid Drive.

Despite all these advantages, Chrysler Industrial Power is not expensive. Production-line methods adapted to specialized industrial engine building, provide a custom-built engine at mass-production prices.

See a Chrysler Industrial Engine Dealer. Or if your problem is special, write us direct: ***Dept. 42, Industrial Engine Division, Chrysler Corporation, Trenton, Mich.***

CHRYSLER
Industrial Engines

HORSEPOWER **WITH A PEDIGREE**

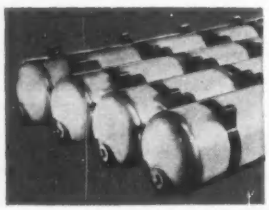
containers to fit the picture . . .

a specialty at **SCAIFE**

If containers are a component part of the equipment you're building or using, you'll find Scaife Company engineering skill and ingenuity can provide the answers to a lot of design problems.

Take one Scaife customer as an example . . . railroad car builders have called on Scaife to build Air Pressure Water Tanks that store the water used in galleys and washrooms of dining and sleeping cars. They know that Scaife is well-fitted, by a century and one-half of broad experience in the pressure vessel field, to develop exactly the right tanks for this kind of specialized service.

Why don't you join the increasing number of up-to-date builders who count on Scaife Company for help when repeat specifications call for containers with strength, lightness, durability and dependability.



120-gallon alloy water tanks for use on railroad passenger cars.

FOUNDED 1902

SCAIFE COMPANY

OAKMONT (Pittsburgh District) PA.

Makers of Pressure Vessels and Drawn Shapes

If Your Product Is Made In—

- FABRIC FORM
- RIBBONS
- SHEETS
- CORDS

This
"MAGIC" BOX
may be what you need.

LOD-CAP

SUPPORTS *ONE* END OF AN IDLER ROLL—

MEASURES TENSIONS

in lbs. pull on remote dial.

Can be installed on any present idler roll and may be mounted in any plane. It's self-contained, small size, easily installed.

AUTOMATIC CONTROL FOR CONSTANT TENSION

This "LOD-CAP" Automatic Control can be added for single or multiple units without changes to remote reading indicating circuit.

Operates on 60 lb. Minimum Air Pressure
No Electric Circuits or Wiring

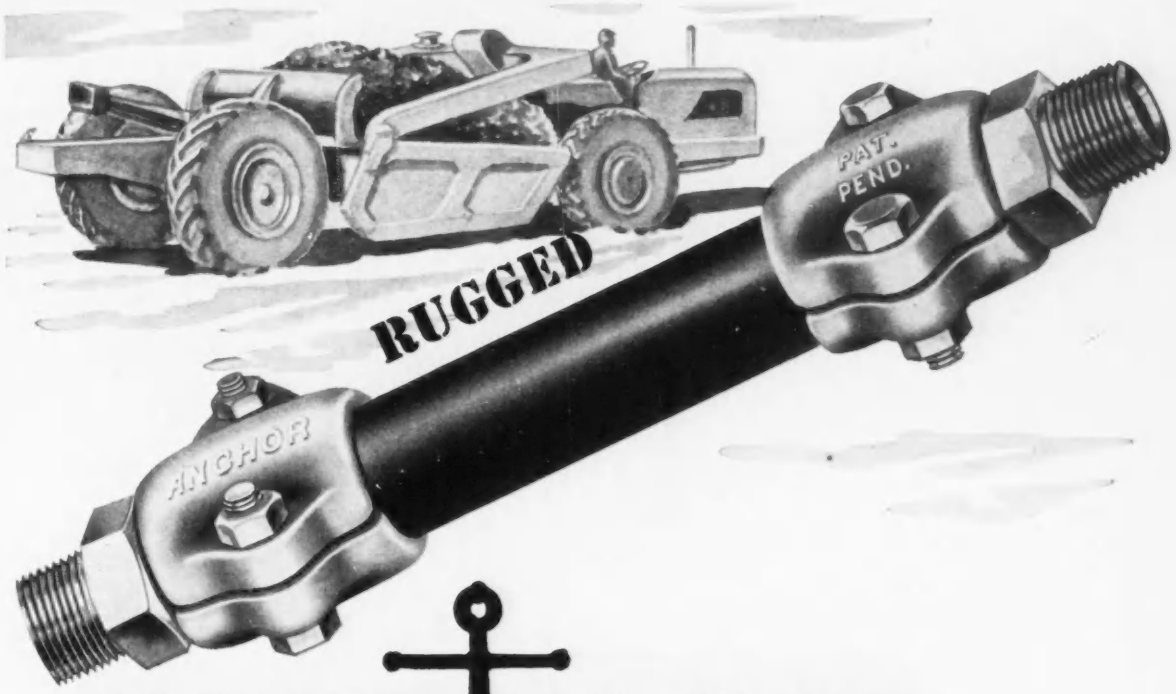
LOW COST—WIDE LOAD RANGE

Simplicity of construction keeps cost down. Load ranges from 0-1 lbs. to 0-12,000 lbs. make LOD-CAPS adaptable to many varied industries.

Write for Data File F3

Open territories available to representatives.

Link ENGINEERING COMPANY
13843 Elmira Detroit 27, Mich.



ANCHOR

CLAMP-TYPE REUSABLE COUPLINGS

— ideal for heavy-duty original-equipment service or emergency repairs in the field

For high or medium pressures—can be used with one- or two-wire braid hose.

Specially designed clamping segments — impulses can't shake them loose, yet coupling is reusable again and again.

Easy to apply — no special tools needed to assemble couplings and hose. Hose cover need not be stripped to apply coupling.

Neat Installation — made possible by compact design of the Anchor clamp and the use of streamlined Anchor adapter unions and related fittings.

Saves Time — you don't have to wait for repairs because you can make up your hose lengths as needed. Stocking problem minimized.

NEW!
REVOLUTIONARY
ANCHOR
SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves. Easy to assemble with small automotive-type wrench.

Get more details. Attach coupon to your letterhead and mail today.

ANCHOR COUPLING CO. INC.

Main Office and Factory: LIBERTYVILLE, ILLINOIS

FACTORY BRANCHES: DETROIT, MICHIGAN • DALLAS, TEXAS

D-14

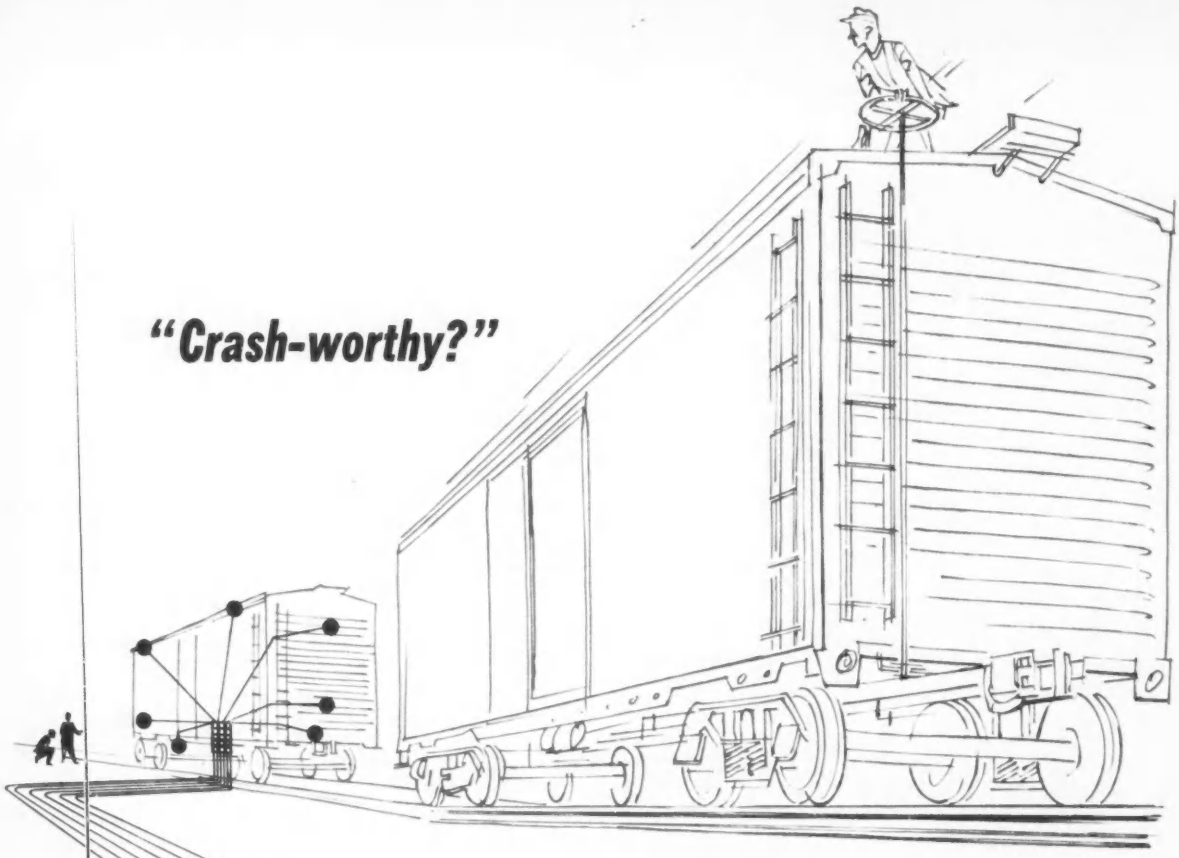
Anchor Coupling Co. Inc.
Dept. PE23, Libertyville, Illinois
I'd like to know more about
☐ Anchor clamp-type reusable couplings
☐ New Anchor Split-flange clamp.
Send me detailed information.

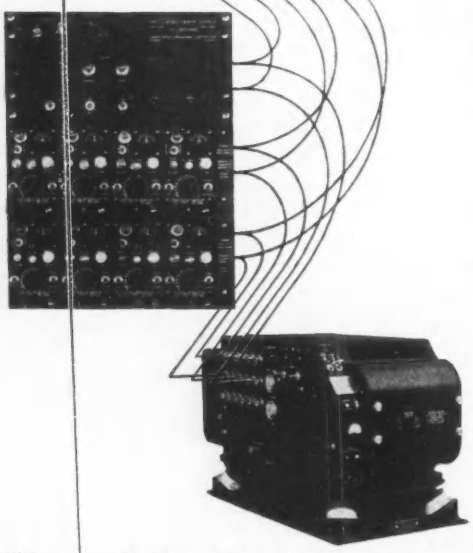
Name..... Title.....

Company Name.....

Company Address.....

City..... (.....) State.....





Pre-check with Consolidated Instrumentation

WHAT happens to structural members and car-body components when freight cars are subjected to the shock impacts and buffeting of hump-yard switching?

To determine stress distribution and to evaluate the effectiveness of shock protection devices, the Pullman-Standard Car Manufacturing Company selected a Consolidated 5-114 Recording Oscillograph, System D Amplifiers, and Bridge Balance as basic recording instruments.

Freight cars, loaded with sand and steel blocks at gross weights ranging from 46,400 pounds (empty) to 164,000 pounds (fully loaded) crashed together 185 times at speeds up to 10 miles per hour.

In this way the dynamics of simultaneous shocks, some as brief as one five-thousandth of a second, were permanently recorded in visual form. From such data will come design changes, giving protection against shock and vibration damage. Thus an improved product is achieved.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dayton.*

analytical instruments for science and industry

Dynamic Recording Systems

such as the one shown here are designed and manufactured by Consolidated. Variations in the arrangement of the equipment are infinite. Applications are widely varied throughout industry and the sciences. A typical recording system includes pickups, amplifiers or bridge balances, and a recording oscillograph. Write for Bulletin CEC 1500B-X1

on your aluminum contract work, check *first* with THE METAL MEN OF MANITOWOC!

ALSO MAKERS OF
MIRRO
The Finest Aluminum
Cooking Utensils

● The voice of experience whispers that good advice in the ear of every conscientious product planner. The Metal Men of Manitowoc, through 55 years of processing, fabricating, and finishing aluminum, have built up a bank of ability upon which the industry of America draws daily.

Careful adherence to your specifications is, of course, important. Equally important is the assistance we can give you in *creating* those specifications. Planning prior to production requires the solving of metallurgical, engineering, and design problems. We maintain technical departments which extend our service beyond the actual making of your product, to help you make it *better*, for less money. Check with us now so that everything will be lined up when you are ready for production.

CONTRACT DIVISION

ALUMINUM GOODS *Manufacturing Company*

MANITOWOC WISCONSIN

FIFTH AVENUE BLDG., NEW YORK 10 MERCHANDISE MART, CHICAGO 54

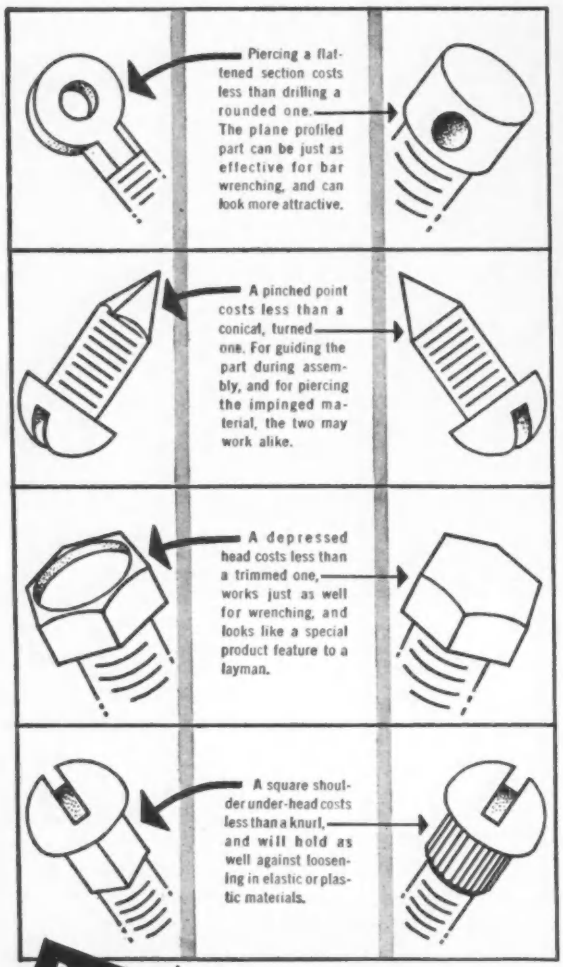
HOW TO

SQUEEZE PENNIES

OUT OF

UPSET SPECIALS COSTS

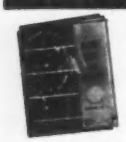
Specially designed upset products are solving thousands of problems. Dozens of design pointers on them are yours for the asking. Send us your sketches, prints, finished products for suggestions.


Piercing a flattened section costs less than drilling a rounded one. The plane profiled part can be just as effective for bar wrenching, and can look more attractive.
A pinched point costs less than a conical, turned one. For guiding the part during assembly, and for piercing the impinged material, the two may work alike.
A depressed head costs less than a trimmed one, works just as well for wrenching, and looks like a special product feature to a layman.
A square shoulder under-head costs less than a knurl, and will hold as well against loosening in elastic or plastic materials.

REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

QUALITY PROMCO BRAND

MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS



WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.

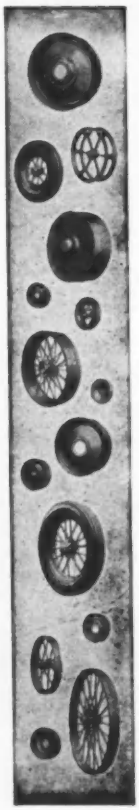
HYDRAULIC VALVES

Pathon

HYDRAULIC CYLINDERS

• WRITE today for literature covering Pathon's new Solenoid Controlled Pilot Operated Hydraulic Valves, Bulletin No. 15 and/or Hydraulic Cylinders, Bulletin No. 17.

PATHON MFG. CO.
3823 PACIFIC AVENUE
CINCINNATI 12, OHIO



FOR FARM AND INDUSTRY

ELECTRIC

WHEELS ARE RIGHT

Over 65 years in wheel manufacturing have given us the "know how"—modern production methods assure long life and efficient wheel performance in the field.

There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

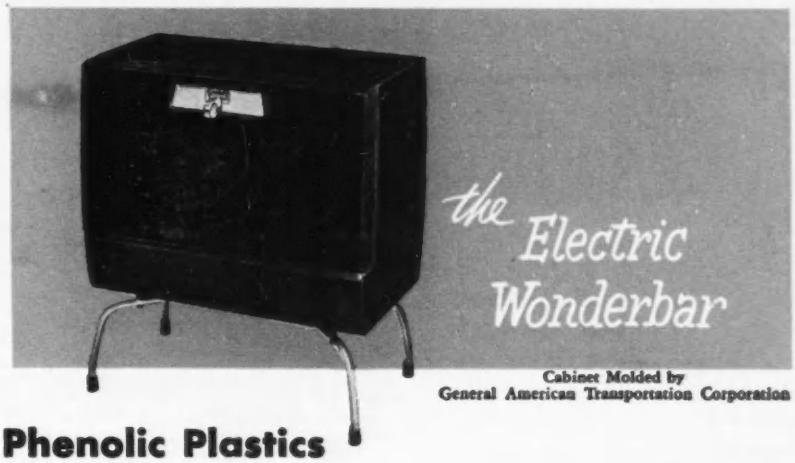
Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

WRITE FOR CATALOG

ELECTRIC WHEEL CO.

2816 CHERRY, QUINCY, ILL.

a NEW idea in refrigerators...



Cabinet Molded by
General American Transportation Corporation

a GREAT idea in Phenolic Plastics

SERVEL's portable "Wonderbar" travels to any room in the house—parks right at your elbow!

Molded of BAKELITE Phenolic Plastic, the cabinet puts this electric refrigerator in the fine furniture class. With its clean modern lines, rich mahogany color, and permanently smooth finish, it "belongs" in living room, bedroom, or den.

BAKELITE Phenolic Plastics are resistant to stains and abrasion—always look clean. Light in weight, they help make the "Wonderbar" easy to move about. They have good thermal characteristics. They're strong—the "Wonderbar" door opens to form a serving shelf, has to take a lot of slamming. They are quickly molded to the precise dimensions needed for quick assembly and tight sealing.

If you're planning a new product—or bringing an old one up-to-date—try BAKELITE Phenolic Plastics. Our engineers will help you.

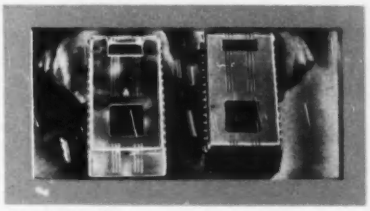
Write Dept. OQ-10.

BAKELITE
TRADE-MARK
PHENOLIC PLASTICS

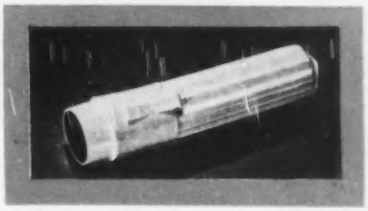
TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada:
Bakelite Company (Canada) Ltd., Belleville, Ont.

AUTO BATTERIES can be dry-charged, shipped in cardboard, kept in storage without deterioration. Unbreakable bottles molded of BAKELITE Polyethylene carry 1.28 sp. g. sulphuric acid separately. Acid easily added to activate batteries. Bottles by Plax Corp., Hartford, Connecticut.

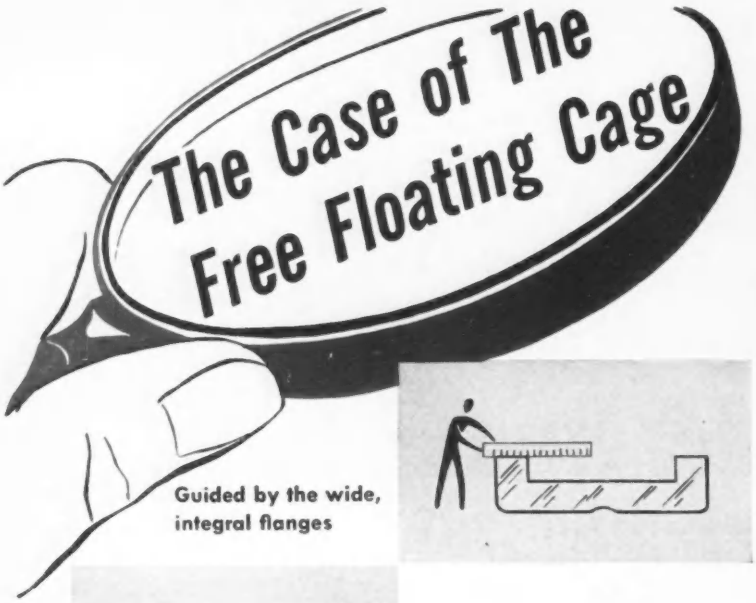


LOW COST thermostat housings, injection-molded of BAKELITE C-11 plastic, have good detail, impact strength, smooth finish. Spray-coated with metallic paint. Easy moldability reduces production cost and mold maintenance. By Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

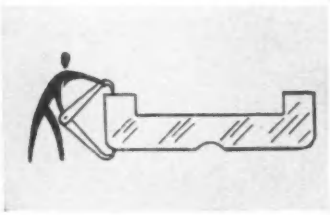


FLEXIBLE CASE for flashlight, molded in one piece from VINYLITE Elastomeric Materials. Heat-sealed, disposable unit is waterproof, tough, resilient, inexpensive. Withstands handling, perspiration, oil, grease. By Hungerford Plastics Corp., Rockaway, N. J.

The Case of The Free Floating Cage

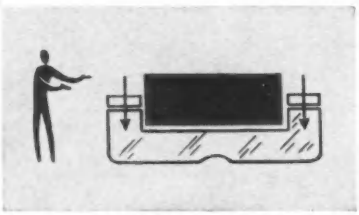


Guided by the wide, integral flanges

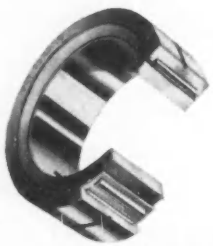


Flanges are thick, solid, really rugged . . .

To give fullest support to the cage



RBC's PITCHLIGN TRADE MARK ROLLER BEARINGS



PITCHLIGN bearings have a full length, free floating cage with *pitch circle contact!* Any tendency of the rollers to thrust is absorbed by the heavy integral flanges of the outer race. Completely relieved of this burden, the cage *cannot* distort and so fail in its vital duty of roller alignment. This is the one positive method of doing away with cocking and skewing. Only PITCHLIGN has it!

PITCHLIGN performs where others fail . . . interchangeable with precision needle bearings, of course. Get the facts!

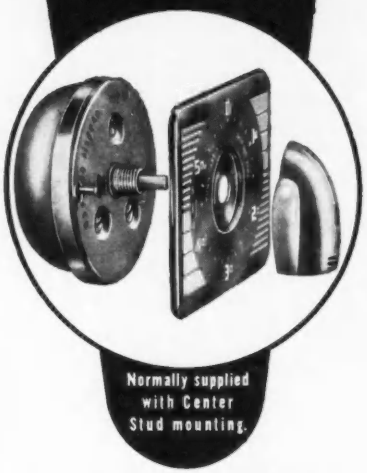
Write for Bulletin SF-166

RBC

ROLLER BEARING COMPANY OF AMERICA • TRENTON, N. J.

Give your appliances this EXTRA VALUE ...at NO extra cost!

MARK-TIME *two-speed* BELL TIMER



Normally supplied with Center Stud mounting.

The exclusive, patented 2-speed feature of this Mark-Time unit makes it TWO timers in one! . . . and puts more "sell" into your appliances!

Here's why: in the long-time position, the user can measure time up to ONE HOUR for baking, roasting, stewing and other lengthy cooking operations . . . can use it as a reminder for appointments and other household jobs, too! By moving the lever to the short-time position, the user can obtain settings within seconds for boiling eggs, pressure cooking . . . precise timing for all short time jobs up to SIX MINUTES, where even fractions of a minute are important.

At the end of the pre-set time period, in either long or short range, this timer gives a clear, resonant bell signal.

Available with a wide variety of modern dials and knobs; also in 2-hour, 12-minute range.

Write today for full details and prices.

MARK-TIME

M. H. RHODES, INC.

HARTFORD, CONNECTICUT

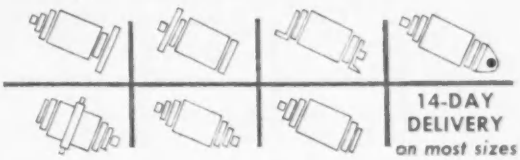
Manufactured and sold in Canada by SPERRY GYROSCOPE OTTAWA, Limited 3 Hamilton St., Ottawa, Ontario, Canada

interchangeable mounts . . .

make

O-M CYLINDERS

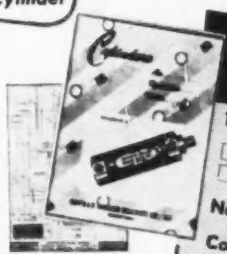
adaptable to any installation! . .



Because the end plugs are tapped for universal mounting, any one type or combination of mounting brackets can be used to install an O-M Cylinder . . . *without disassembling or changing the cylinder.* Interlocking mechanism eliminates projecting end caps and tie rods, assuring better alignment and friction-free performance. Thus, O-M Cylinders fit where others won't . . . require ⅓ less space than conventional type cylinders of the same bore . . . are easily removed, inspected, repaired.

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. All machined steel with bearing bronze, no castings. Completely interchangeable parts.

Write today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.



ORTMAN MILLER MACHINE CO.

1218 150th Street, Hammond, Indiana

☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name ..... Position .....

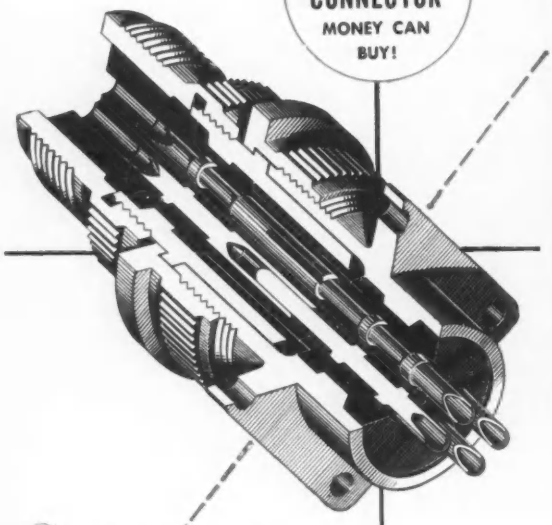
Company .....

Address .....

City ..... Zone ..... State .....

mail coupon now!

The Finest
ELECTRICAL CONNECTOR MONEY CAN BUY!



Scinflex

ASSURES YOU THE LOWEST VOLTAGE DROP IN THE INDUSTRY!

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX
ELECTRICAL CONNECTORS

Bendix

SCINTILLA MAGNETO DIVISION of SIDNEY, NEW YORK

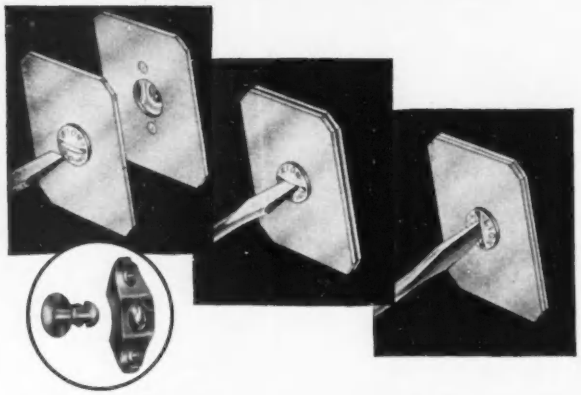
Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

For Parts that must be
TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

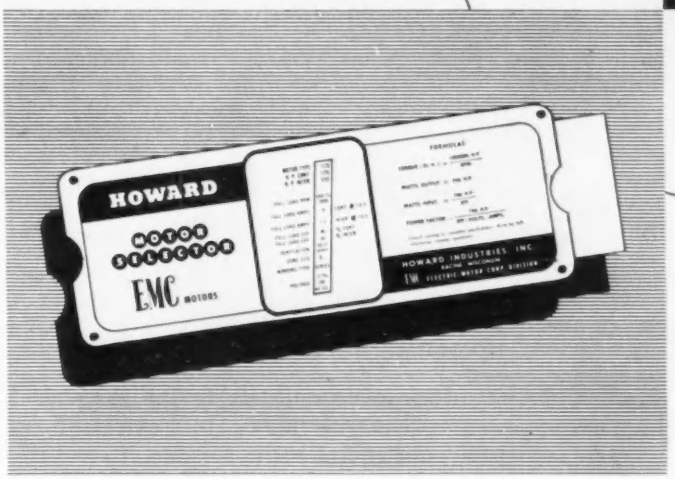
TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

LION
FASTENERS, INC.

300 Main St., Honeoye Falls, N.Y.

MOTOR INFORMATION
at your fingertips...



with the Howard
MOTOR SELECTOR

AVAILABLE AT NO COST!

Here's your quick reference to the complete line of EMC and CYCLOHM fractional h. p. motors in ratings from ½ H. P. to 1/2000 H. P. Gives you all the ready data you need to select the right motor for your particular requirements. You'll find a hundred uses for the Howard Motor Selector and you'll save hours of valuable time looking up specifications.

To get one of these handy slide charts, just fill in the coupon below and mail today. We'll send you the HOWARD MOTOR SELECTOR by return mail. Send for yours today!

EMC and CYCLOHM Fractional H. P. Motors

Universal and Direct Current 1/1000 to 1/2 h.p.
Shaded Pole 1/2000 to 1/15 h.p. • **Induction** 1/1400 to 1/4 h.p.

HOWARD

HOWARD INDUSTRIES, INC. • RACINE, WISCONSIN
DIVISIONS:
EMC ELECTRIC MOTOR CORP. CYCLOHM MOTOR CORP.

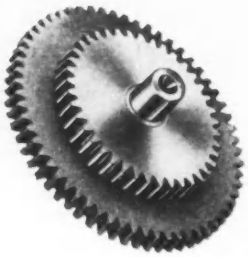
DEPT. PE1, HOWARD INDUSTRIES, INC., RACINE, WIS.
Please send me the HOWARD MOTOR SELECTOR (at no cost.)

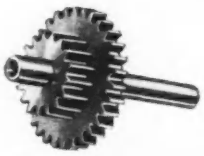
NAME.....TITLE.....

COMPANY NAME.....

ADDRESS.....

CITY.....STATE.....





Keep free of costly assembly headaches with small gears by..

Assembly lines run smoother, with greater speed and efficiency, when your Small Gearing is made by G.S. It is consistent *uniformity* that turns the trick! Over 35 years of specialization has taught us to mass-produce Fractional Horsepower Gearing to standards of quality often considered impossible! If you want production quantities of Small Gears that soothe assembly headaches, *let G.S. make them for you!* More and more critical buyers are profiting by the superior skills and services only G.S. can give. Call us early when new designs are considered. We'll try to point the way toward new production speed and economies.

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

GEAR Specialties, Inc.

Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

This continuous roll machine at the C-D-F, Bridgeport, Pa. plant makes top quality sheet fibre for electrical insulation. Corrosion-resistant rollers are made from laminated Dilecto, another famous C-D-F product.

CDF

DIAMOND VULCANIZED FIBRE

- mechanically and electrically strong
- moisture, arc and chemical resistant
- high dielectric strength
- easily machined and formed
- low-cost with long life

watched all the way...
DIAMOND VULCANIZED FIBRE

Naturally it takes a big, well-equipped company like C-D-F to make fibre. It also requires a special brand of know-how and long experience to take rag paper (we make our own), zinc chloride and water and come up with a low-cost uniform product that can be adapted to a million uses.

Maybe you think that vulcanized fibre has been replaced by many newer, more publicized materials. Actually Diamond Vulcanized Fibre today has more applications, more unique qualities, more product design value than ever before.

If you need a dependable source for bone, commercial, Diamond "fish paper" insulation, tubes, rods, receptacles . . . talk to the man who knows . . . your C-D-F sales engineer (offices in all principal cities), or write C-D-F, Newark, Delaware.

THE NAME TO REMEMBER CDF DIAMOND VULCANIZED FIBRE

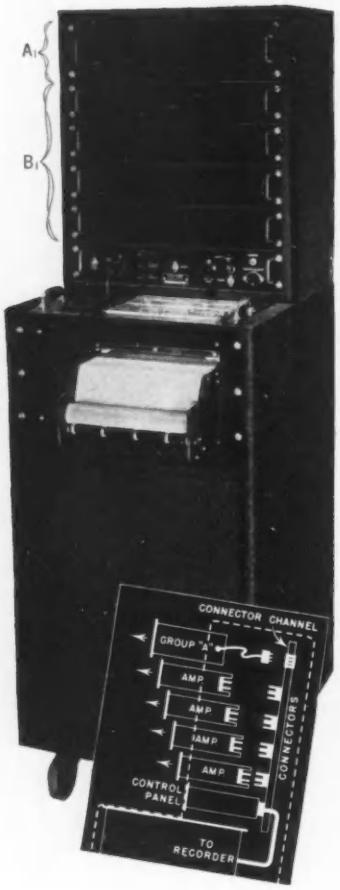
Continental-Diamond Fibre Company

NEWARK 40, DELAWARE

It's VERSATILITY that sells SANBORN in the field of Industrial Recording

As indicated by references at the right, you may have a choice of five different instruments (A) for quick and convenient standard rack mounting in the system at A_1, PLUS a choice of up to four of any of the three different type amplifiers (B) or any combination of these amplifiers with the

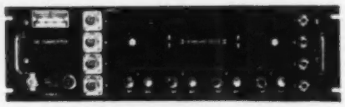
SANBORN FOUR-CHANNEL OSCILLOGRAPH RECORDING SYSTEM (MODEL 67)



A

DC PREAMPLIFIER

AC PREAMPLIFIER



DC CONVERTER—for low level DC recording such as thermocouple output.

TRIPLEXER—when coupled to a DC amplifier permits the recording of three events in one channel.

THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

B

DC (General Purpose) AMPLIFIER

STRAIN GAGE (Carrier) AMPLIFIER

SERVO MONITOR AMPLIFIER—a phase discriminating AC amplifier used in servo design and testing.

As shown in the diagram, removing or interchanging any of the amplifiers or other instruments is simply a matter of sliding the unit in or out of the mounting rack where contact is made automatically by plug-in connectors. Screws at the four corners of the panel hold the instrument in place.

Other features of this system which add to Sanborn VERSATILITY are the choice of eight paper speeds – 50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec, and the use of either 4-, 2-, or 1-channel recording paper.

And, of course there are these popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

Sanborn Recording Systems may be used to record any one or more of a wide variety of phenomena whose characteristics range from static to 100 cycles per second. If your recording problem is not one which can be solved by standard Sanborn equipment, our engineers will be glad to suggest ways in which modifications of it may suit your requirements.

A complete catalog of Sanborn Industrial Recording Equipment will be sent gladly on your request.

SANBORN COMPANY
CAMBRIDGE 39, MASS.

SANBORN 1-, AND 2-CHANNEL RECORDING SYSTEMS

One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.

POPE

SUPER-PRECISION SPINDLES

READY TODAY FOR THE GRINDERS AND MACHINE TOOLS OF TOMORROW

Indicator readings taken on the noses of thousands of POPE Super-Precision Spindles show less than one half of one ten thousandth (less than 50 millionths) of an inch of total eccentricity.

Whenever you want Precision Motorized or Belt Driven Spindles, in quantities of one, a hundred or more — whatever the kind of work you want to do — let us submit recommendations and estimates.

The SUPER-PRECISION Of Today Is The STANDARD Of Tomorrow

No. 87

POPE POPE MACHINERY CORPORATION

SPECS FOR NON-FERROUS FINISHING GOT YOU DOWN?

FIND OUT ABOUT **IRIDITE**® TODAY for finishing ZINC, CADMIUM, ALUMINUM, CUPROUS METALS

WANT CORROSION RESISTANCE? Iridite will give you better-than-specification protection against corrosion.

WANT PAINT ADHERENCE? Iridite provides a firm and lasting base for paint by preventing under-film corrosion.

WANT EYE-APPEAL? Iridite can give you a variety of finishes, depending upon the metal being finished . . . from clear and sparkling bright or military olive drab, to attractive dyed colors.

BEST OF ALL, any Iridite finish is economical and easy to apply.

for example: **IRIDITE**® (AL-COAT) REDUCES NEED FOR ANODIZING

Simple chemical dip; immersion time only 10 seconds to 2 minutes; no sealing dip; color is clear or yellow depending upon your requirements; salt spray resistance equivalent to 20 to 30 minutes of anodizing, eliminates need for costly racks and electrical power.

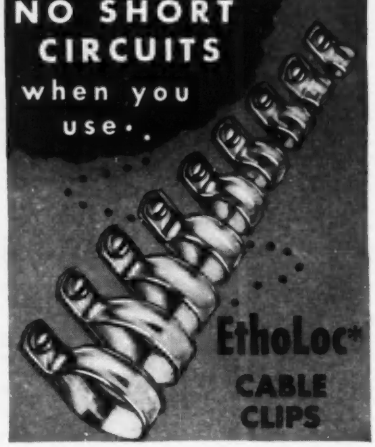
WANT TO KNOW MORE? Write for literature and send production samples for free test processing. See "Plating Supplies" in your classified telephone directory or write direct.

Iridite is approved under government specifications.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ASTP Finishing Equipment. West Coast Licensee: L. H. BUTCHER COMPANY

NO SHORT CIRCUITS when you use . .



*TRADE MARK PAT. PEND.

ALL SIZES
⅛" dia. to 1¼" dia.

Made of TOUGH, DURABLE ETHYL CELLULOSE PLASTIC —FLEXIBLE, EASY TO INSTALL

Write for Sample and Full Information, including Strength Tests and Prices

WECKESSER CO.

ALSO MFRS. OF ALL NYLON CABLE CLIPS

5265 N. Avondale Ave. • Chicago 30, Ill.

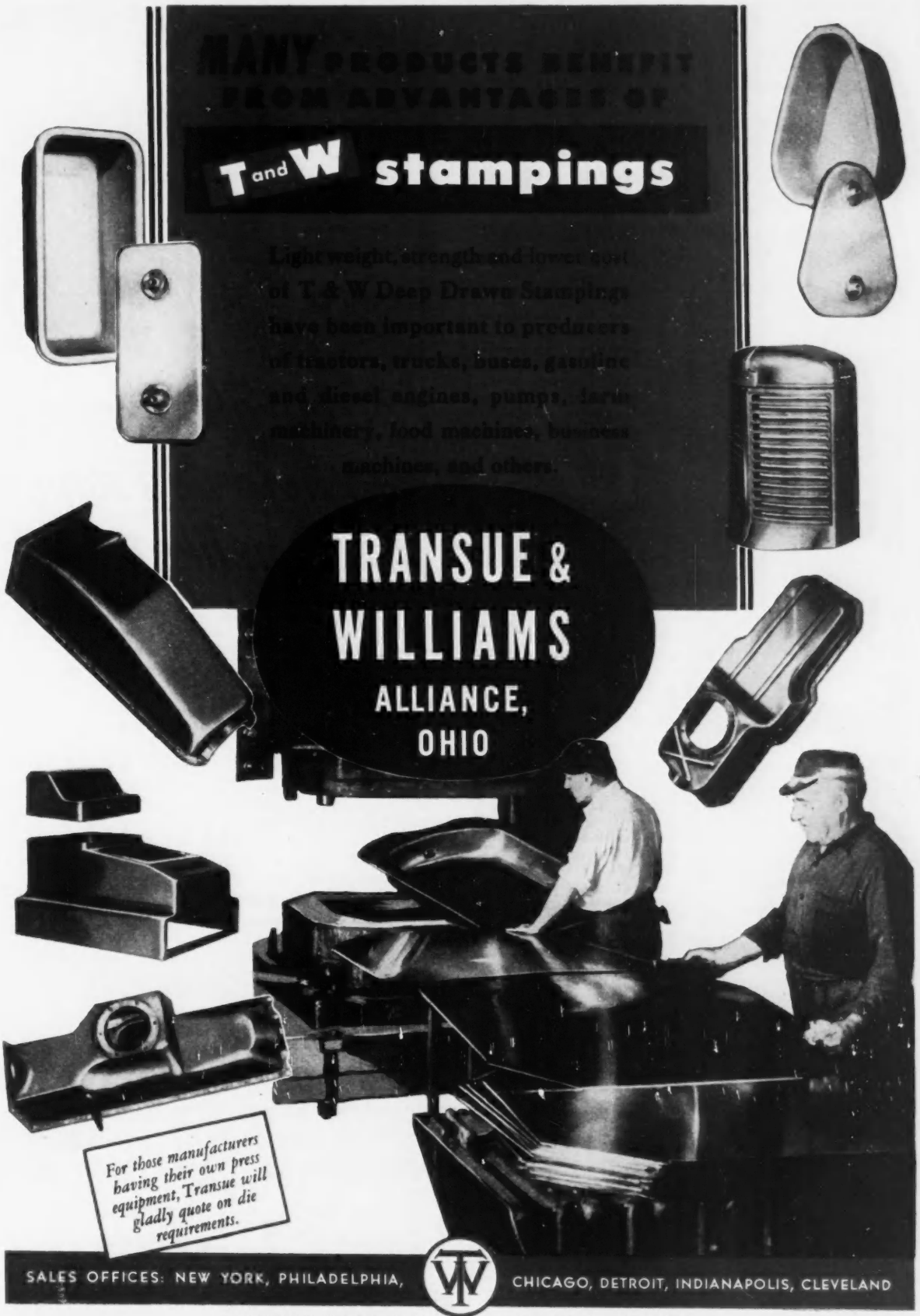
HAVE YOU A GASKET PROBLEM?

For nearly half a century Vellumoid has pioneered in the gasket field. We have a wide variety of non-metallic gasket materials that have solved many difficult problems.

Ask for our Technical Data Book and samples for testing.

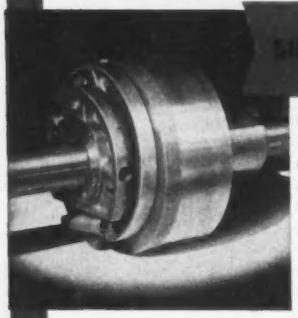
VELLUMOID
444 VELLUMOID
VELBESTOS
(Compressed Asbestos)
VELLUTEX
VELCOREX
VELBUNA
THIOKOL & BUNA N. Coated

THE VELLUMOID CO.
Worcester (6) Mass.


MANY PRODUCTS BENEFIT FROM ADVANTAGES OF
T and W stampings
Light weight, strength and lower cost of T & W Deep Drawn Stampings have been important to producers of tractors, trucks, buses, gasoline and diesel engines, pumps, farm machinery, food machines, business machines, and others.
TRANSUE & WILLIAMS
ALLIANCE, OHIO
For those manufacturers having their own press equipment, Transue will gladly quote on die requirements.
SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, DETROIT, INDIANAPOLIS, CLEVELAND
DESIGNERS AND MAKERS OF DEEP DRAWN STAMPINGS

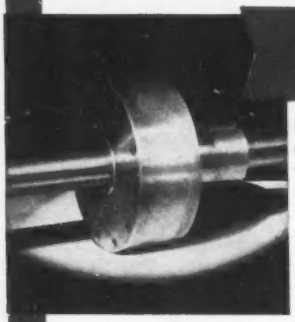
HILLIARD *Clutches*

FOR POWER CONTROL DESIGNS



HILLIARD SINGLE REVOLUTION CLUTCH

Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



HILLIARD OVER-RUNNING CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unsurpassed for automatic two-speed drives, dual drives, stand-by drives and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

HILLIARD SLIP CLUTCH

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations and many other uses.

★ HILLIARD CLUTCHES and COUPLINGS make machine drive and power transmission more efficient and economical. Experienced engineers will be glad to offer their advice on any problems. Complete descriptive material will be furnished on request.

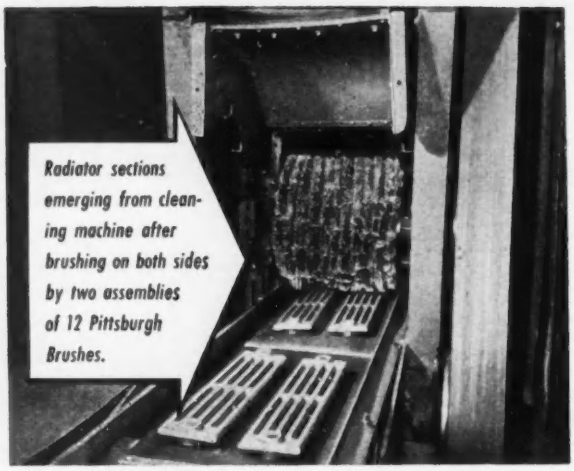
WRITE TODAY for our illustrated brochure #MP-4 for information.

CLUTCH MAKERS FOR OVER FORTY-FIVE YEARS

THE HILLIARD *Corporation*

101 W. FOURTH STREET, ELMIRA, N. Y.

In Canada • • • **UPTON - BRADEEN - JAMES, LTD.**



Radiator sections emerging from cleaning machine after brushing on both sides by two assemblies of 12 Pittsburgh Brushes.

Pittsburgh Brushes can help you solve problems like these!

Cleaning Narrow Spaces—National Radiator Company, Johnstown, Pa., cleans 30,000 radiator sections a week! To insure a perfect final finish, even the narrowest spaces must be absolutely clean prior to assembly. Pittsburgh engineers were asked to design a brush that would reach these spaces and would fit National's existing machine. Successful? National reports: "Pittsburgh Brushes do a better job of cleaning and are more economical!"

Preparing Chills—At Continental Foundry & Machine Co., East Chicago, Indiana, chills used to cast iron rolls must be cleaned of the oxidized metal remaining from previous usage, as well as dirt and grease accumulated in storage. After experimenting with other brushes, Continental chose Pittsburgh because they "do the job better and stand up longer than any previously used!"

Improving Original Equipment—The Sommer and Maca Glass Machinery Co., Chicago, Illinois, uses Pittsburgh Brushes in the automatic washing machines they manufacture. Brushes formerly used simply didn't have the over-all density pattern needed. Pittsburgh engineers studied the problem and designed a brush which Sommer and Maca approved "because of (its) denser bristle pattern and lower cost."

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh cuts brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Maryland.

PITTSBURGH

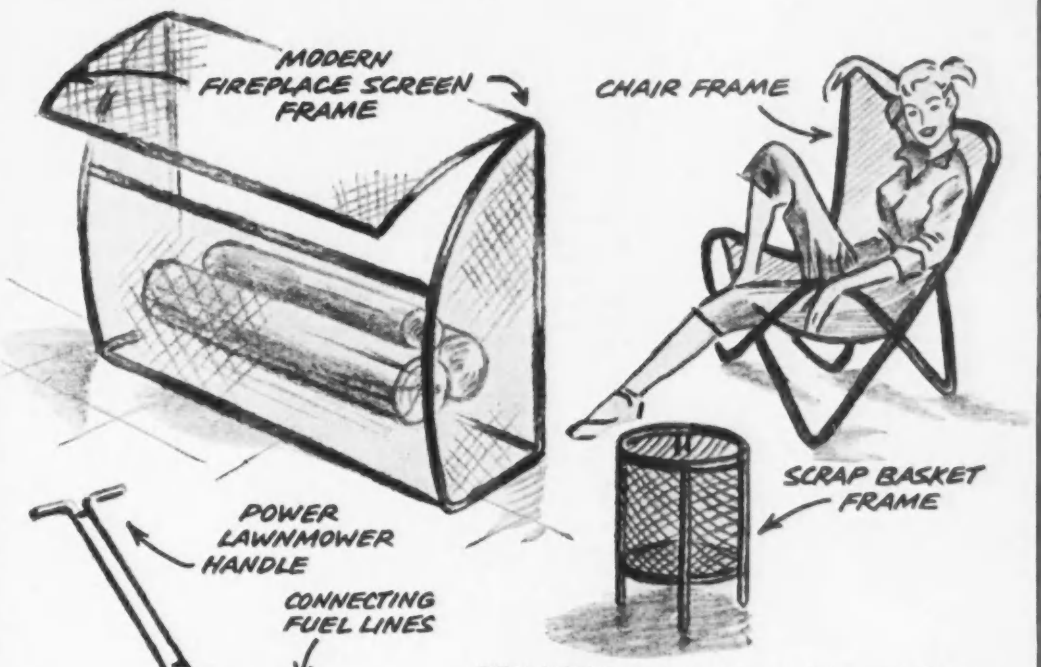
Power Driven

BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



REMARKS Need better tubing performance? Want easier, lower-cost fabrication? In Bundyweld, you buy the industry's most versatile, dependable tubing -- backed by engineering skills dedicated to helping Bundy customers save time, materials, money.

WRITE → us for catalog or for help on your tubing idea or tubing problem.
BUNDY TUBING CO., DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

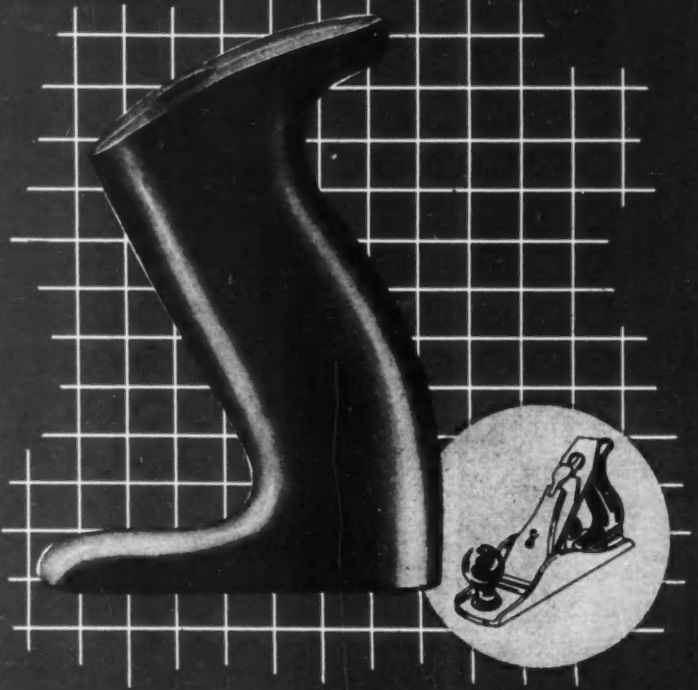
← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: *Cambridge, 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Precision molding of components to tight tolerances!

Complicated thermoplastic molding.

Low cost — high volume handle moldings!



plastic molding applications by SHAW...

Custom moldings by Shaw have been foremost in the industry for over 60 years. Regardless of the application demands in molding materials, Shaw has a consistent record for customer satisfaction every time! The components illustrated above are examples of Shaw's solution to various molding problems for leading manufacturers.

Now is the time to consider whether you can capitalize on the unique properties of plastics in the fabrication of your product. Write to determine how Shaw's experience and facilities can best serve you. No matter what your component or the concept required, when you think of plastic molding, remember — Shaw.

Send for Shaw's Plastic Properties and Uses indicator disc — it's FREE!

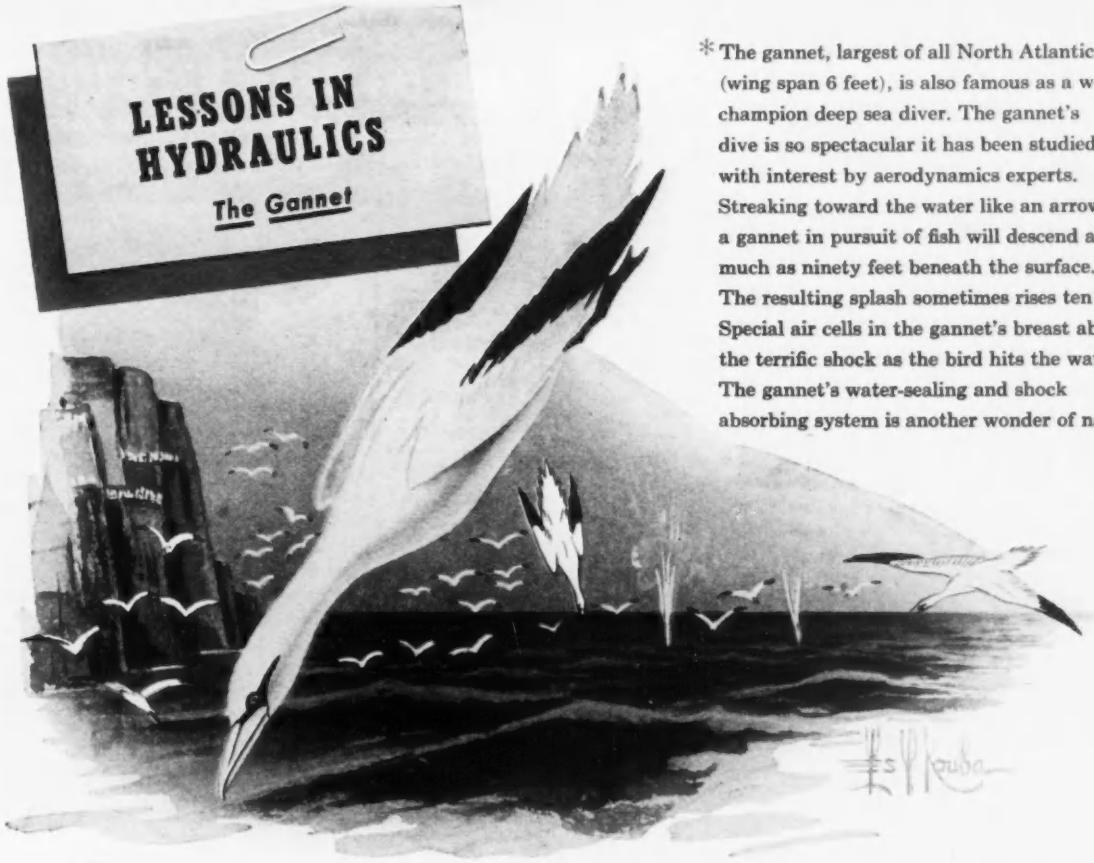
SINCE 1892

SHAW INSULATOR COMPANY

162 COIT STREET, IRVINGTON 11, NEW JERSEY

Transfer • Compression • Injection

SHAW



* The gannet, largest of all North Atlantic birds (wing span 6 feet), is also famous as a world champion deep sea diver. The gannet's dive is so spectacular it has been studied with interest by aerodynamics experts. Streaking toward the water like an arrow, a gannet in pursuit of fish will descend as much as ninety feet beneath the surface. The resulting splash sometimes rises ten feet. Special air cells in the gannet's breast absorb the terrific shock as the bird hits the water. The gannet's water-sealing and shock absorbing system is another wonder of nature.

THE BIRD WITH SHOCK PROTECTION

Minnesota O-Rings are "doughnut shaped" packings used as shaft seals in air, gas or hydraulic systems. Every day, leading product engineers are proving the dependability and wide application of O-Rings by discovering new uses for these unique seals. Minnesota O-Rings are made from special compounds of natural or synthetic rubber to meet exacting product specifications for close tolerances and uniform quality. Hundreds of successful installations have been designed into such equipment as hydraulic rams and regulating valves . . . remote control mechanisms . . . air cylinders . . . water pumps . . . gasoline and steam engines. For prompt analysis and quotation on your next packing installation, send us your blueprints or specifications.

* *The many advantages and applications of injection molded O-Rings merit your investigation. Bulletin available on request.*

Manufacturers of All Types of Small Rubber Parts

MINNESOTA RUBBER & GASKET COMPANY

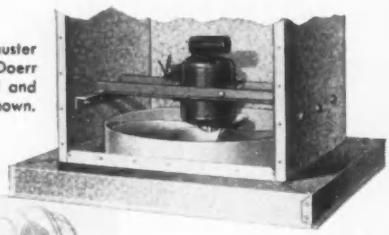
3630 WOODDALE AVE., MINNEAPOLIS 16, MINN. • Phone WHittier 6511

AFFILIATED WITH MINNESOTA SILICONE RUBBER CO. • *OFFICES IN PRINCIPAL CITIES*

DOERR MOTORS

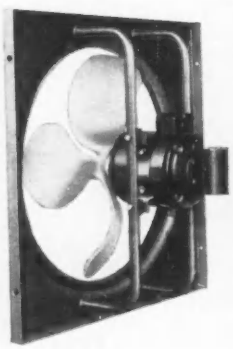
POWER POPULAR
AIRMASTER
PRODUCTS

• Over ten years ago Airmaster Corporation of Chicago began using our motors. We were then known as Electro Machines, Inc. We are proud to have retained our position as their foremost motor supplier during these years, and have steadily expanded our line to meet their ever-increasing needs.



Airmaster roof exhauster powered by Doerr motor. Top hood and louvers not shown.

Airmaster 24" pedestal fan driven by 2-speed motor with pull chain switch.



Direct drive 24" exhaust fan with permanent split capacitor motor.

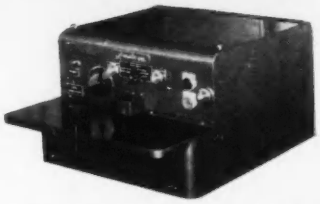
YOU GET MORE WITH DOERR!

DOERR
Electric Corporation
CEDARBURG, WISCONSIN

Electric Motors from 1/30 to 5 hp. Standard, or Designed to Your Specifications

The new Ametron
ANALOG DATA RECORDER
simplifies exact measurement and numerical printing of many Analog quantities

TEMPERATURE • WEIGHT • PRESSURE • VOLTAGE • LIGHT INTENSITY • CURRENT • PH CONCENTRATION • RESISTANCE • R.P.M. • STRESS-STRAIN • DISTANCE • ANGLE DISPLACEMENT • Plus Many Others



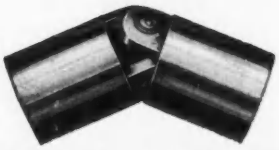
The versatile Analog Data Recorder provides visual or printed records of virtually any physical quantity converted into a corresponding voltage through various functionally operated sensing devices—thermocouples, photocells, tachometer generators, etc. Prints accurate numerical quantity in full figures on tape, tickets or cards.

Write for new brochure AN31

STANDARD OF ACCURACY SINCE 1888
STREETER-AMET COMPANY
4101 N. RAVENSWOOD AVENUE • CHICAGO 13, ILLINOIS
Branches in Pittsburgh, Pa., Allentown, Pa. and Birmingham, Ala.

ATLAS HIGH or LOW SPEED
UNIVERSAL JOINTS

IMPROVE YOUR PRODUCT...
REDUCE YOUR COSTS...



GRAY & PRIOR

Quotations and detailed Catalog available on request. Write today!

THE GRAY & PRIOR MACHINE CO.
623 WINDSOR ST. HARTFORD, CONN., U. S. A.

LEFAX POCKET SIZE TECHNICAL DATA BOOKS $1. EACH

Printed on loose leaf, six hole, 6-¾" x 3-¾" bond paper, each book contains about 140 pages of technical data, presenting condensed, accurate and essential data for the engineer, technical worker and business man.

Architecture
Home Heating
Illumination
Electrician's Data
Builder's Data
Lumber Data
Air Conditioning
General Math.
Math. Tables
Physics
Chemical Tables
Metals
Gen'l. Chemistry
Reinf. Concrete
Building Constr.
Radio
Television & FM
Electricity AC
Electricity, DC
AC motors and Generators
Transformers, Relays, Meters
Hydraulics
Surveying
Mech. Drawing
Machine Design
Machinists Data
Piping Data
Surveying Tables
Trig-Log Tables
Metallurgy
Analytic Chemistry
Highway Engineering
Mech. of Materials
Pwr. Trans. Mchy.
Thermodyn. Tbls. & Charts
Phys. & Thermodyn. Data
Phys. & Org. Chem.

Write for FREE Catalog (over 2000 listings.) See for yourself how helpful LEFAX can be to you. Send $1. for each book, or $5. for any six books listed above, to:

LEFAX DEPT. PE-14 Philadelphia 7, Pa.

Punched and formed pieces of tough, resilient National Vulcanized Fibre reinforce spectacle case to provide lasting shape retention and serviceability.

contributes to an improved product— in spectacle cases for American Optical COMPANY

National Laminated Plastics nationally known—nationally accepted

This practical use of National Vulcanized Fibre by American Optical Company in their attractive spectacle cases is typical of the countless contributions National Vulcanized Fibre—*the material of a million uses*—makes to industry and business.

National Vulcanized Fibre applications, both mechanical and electrical, are varied and extensive. In mechanical applications it is desirable because it possesses exceptional tensile and crushing strength, toughness, density and resistance to wear—coupled with ease of fabrication. It actually improves with age; for many mechanical purposes it is better, more durable than metal.

In the electrical field National Vulcanized Fibre has been the standard insulation for years. It has high dielectric strength and, when subjected to hot electrical arcing, it evolves neutral gas which extinguishes arc without "tracking." Many electric appliances find National Vulcanized Fibre to be the *one best material* for one or more of their parts.

Available in various grades and colors; and in sheets, rods, tubes and special shapes. Write for detailed literature and engineering service information—

NATIONAL VULCANIZED FIBRE CO.

Wilmington Delaware

Offices in Principal Cities

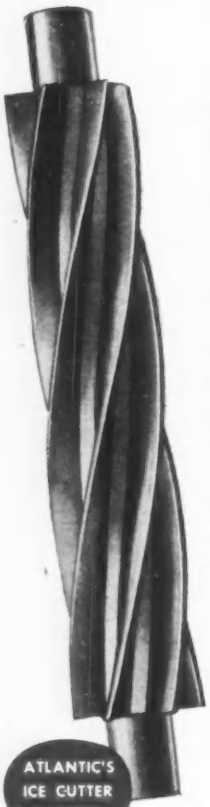
Since 1873

COLD FACTS

about YORK'S new ICE CUTTER

YORK FLAK-ICE AUTOMATIC ICE MAKER, MODEL DER-2

ICE HARVESTING SYSTEM



ATLANTIC'S ICE CUTTER CASTING

AN IMPORTANT COMPONENT of York Corporation's most recent development, the York-FlakIce Automatic Ice Maker, is Atlantic's ice cutter casting. It cuts the ice into curved flakes... so delicate they will not damage or puncture delicate rose petals.

YORK'S ORIGINAL CONCEPTION of the ice cutter... a vital part of the ice harvesting system ...consisted of three stainless steel parts which had not only to be machined, but welded together.

ATLANTIC'S ENGINEERS suggested a design that eliminated these costly operations and increased the productive efficiency of the ice cutter. Six spiral blades on a center shaft were all plaster mold cast in one piece of Atlantalloy #31 High Tensile Manganese Bronze... an alloy of great endurance and strength.

York will testify that Atlantic's all-in-one-piece ice cutter casting surpassed all requirements for high physical values, closely-held tolerances, satin-smooth finish, fine-grained structure, clean-cut surfaces... and afforded them substantial savings over former costs.

Find out how the Atlantalloy plaster mold casting process can help solve some of your problems. Write for a free copy of "High Quality Precision Castings for Industry" today!

ATLANTIC Established 1937
CASTING and ENGINEERING CORP.
721 Bloomfield Avenue • Clifton, N. J. • PRescott 9-2450

Effective even where other lubricants have failed

Moly-sulfide

A LITTLE DOES A LOT

Moly-sulfide, a solid film lubricant, stands out most where the lubricating conditions are the most difficult. If you have to contend with extreme conditions of pressure, temperature, fretting, or velocity, you should try *Moly-sulfide*. First write for a copy of this free 40-page booklet which shows where the above conditions have already been overcome in the shop and in the field.

Climax Molybdenum Company
500 Fifth Avenue
New York City 36 N.Y.

Please send me your Free Booklet

Name.....
Position.....
Company.....
Address.....

MOLY

PE. 2 MS 7-A

FAWICK CLUTCH & BRAKE ENGINEERING

What FAWICK 3-POINT ADVANTAGES MEAN TO *Your* MACHINE

DESIGN

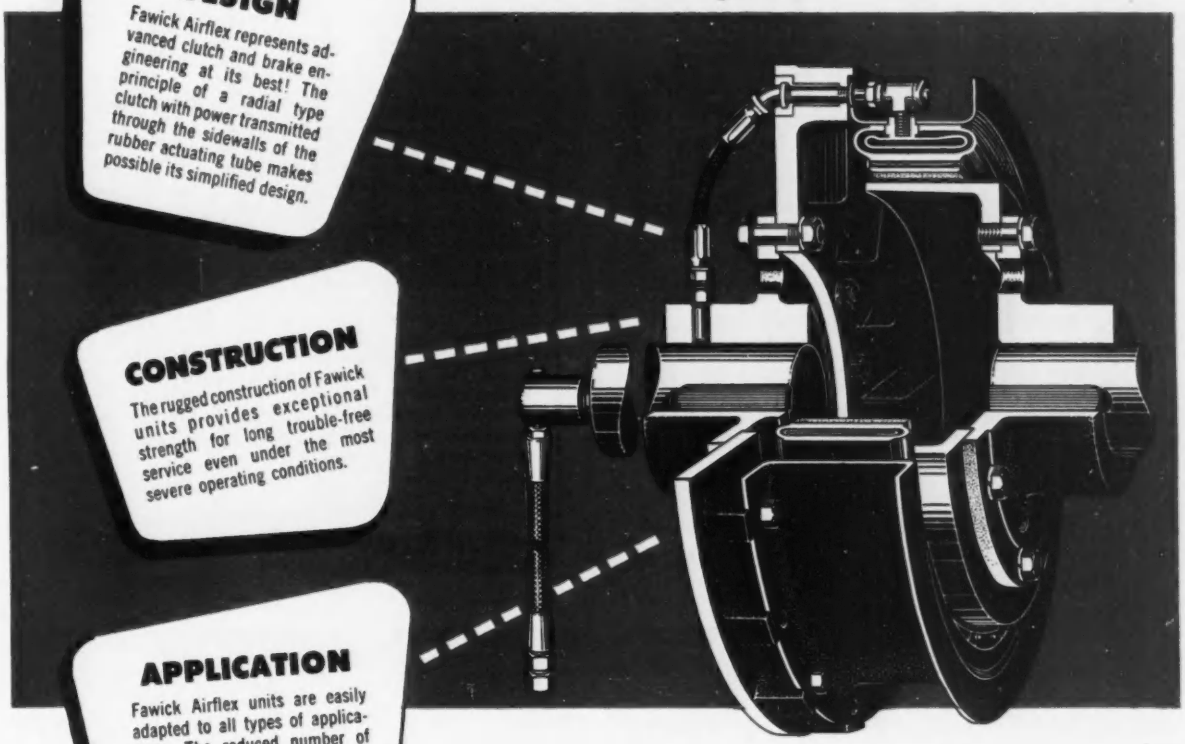
Fawick Airflex represents advanced clutch and brake engineering at its best! The principle of a radial type clutch with power transmitted through the sidewalls of the rubber actuating tube makes possible its simplified design.

CONSTRUCTION

The rugged construction of Fawick units provides exceptional strength for long trouble-free service even under the most severe operating conditions.

APPLICATION

Fawick Airflex units are easily adapted to all types of applications. The reduced number of parts and elimination of mechanical linkages make possible compact installation on all types of machinery.



When designing or engineering high-efficiency machines, insure peak performance of the finished equipment by specifying FAWICK Airflex CLUTCHES AND BRAKES.

Their advantages in design, construction and application add much to any machine. The *extra* advantages of their operating features provide machines with the *best* in advanced clutch and brake performance.

FAWICK *Plus* ADVANTAGES IN MACHINE OPERATION

COOLER CLUTCH OPERATION

•

CUSHIONED DEPENDABLE ACTION

•

SELF-ADJUSTMENT FOR WEAR

•

LONG LIFE — LOW MAINTENANCE

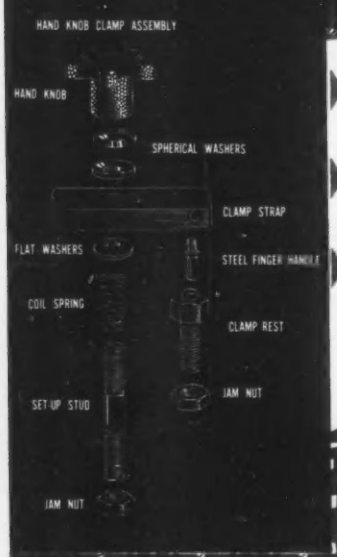
FAWICK AIRFLEX DIVISION
FEDERAL FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO

For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 400-A.

FAWICK *Airflex*
INDUSTRIAL CLUTCHES AND BRAKES

Save Tool and Design Costs

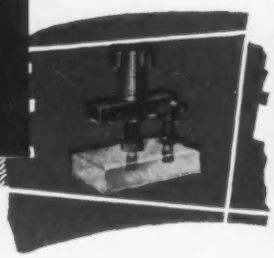
SPECIFY Morton FIXTURE CLAMPS AND COMPONENTS



IMMEDIATE DELIVERY

NATIONALLY USED AS STANDARDS

WE STAND BACK OF EVERY PRODUCT WE MANUFACTURE



ASSURED QUALITY, SERVICE AND FINE WORKMANSHIP

All precision made of heat treated selected steel, cadmium plated and rust proof mid-nite black finish. Widest range of sizes and types to fit the most rigid and exacting requirements.

Complete Clamp Assemblies or any of their Component Parts. Economize by using them as standards in your plant.

WRITE TODAY

For our 72 page illustrated catalog. Contains full size tracing templates of each product, bound in loose leaf style for easy removal.

MORTON MACHINE WORKS

2421 WOLCOTT STREET • DETROIT 20, MICHIGAN

Betcha we make it!

If it's a *float operated* FEEDER — or a *float operated* SWITCH

IF YOUR product involves a float-operated valve or float-operated switch, chances are we have just what you need to perform the function you require . . . always better and usually at lower cost.

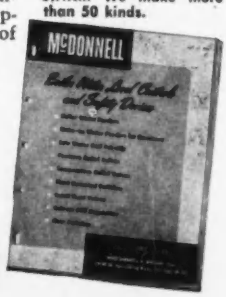
We can give you an almost endless variety of float-operated valves for automatically feeding almost any liquid to maintain levels, supply, make-up, etc. They cover a wide range of working pressures and feeding capacities.

We can also supply an even wider variety of float switches . . . for stopping and starting heat sources; controlling pumps, and so on down the list. We even make explosion-proof types (Underwriters' Approved) for use in the presence of explosive vapors.

The McDonnell catalog lists more than a hundred variants of our products. It's a must to designers of products involving automatic valves or switches.

A built-in type of liquid feeder. We make more than 30 types.

A built-in type of float switch. We make more than 50 kinds.



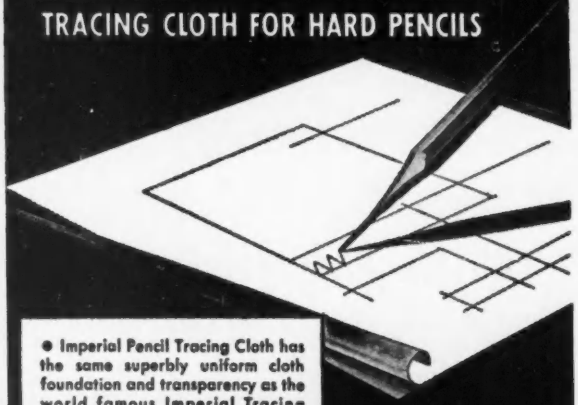
McDONNELL & MILLER, INC.
3500 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well

ASK FOR CATALOG

Imperial

TRACING CLOTH FOR HARD PENCILS



• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

Imperial

PENCIL TRACING CLOTH

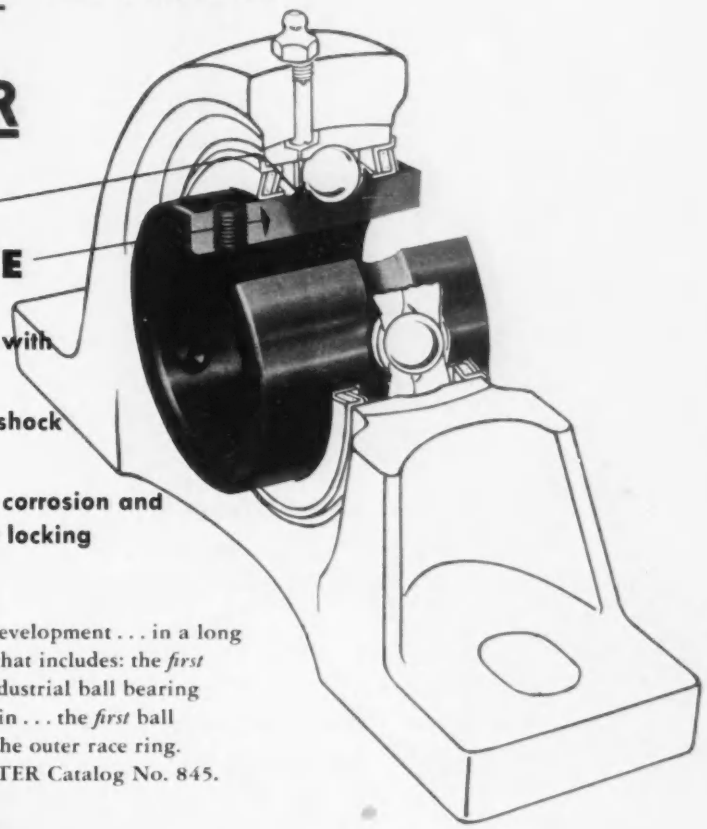
SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

ZONE HARDENING*

for MAXIMUM LIFE EXPECTANCY in EVERY BEARING!

Only **SEALMASTER**

is **HARD HERE**
but **SOFT HERE**



- to permit race-to-shaft locking with increased holding power
- to insure greater resistance to shock and vibration
- to minimize danger of fretting corrosion and eliminate shaft wear by firmer locking of bearing to shaft

Zone Hardening is another major development . . . in a long history of SEALMASTER advances that includes: the *first* self-aligning, permanently sealed industrial ball bearing unit . . . the *first* outer race locking pin . . . the *first* ball retainer riding the inner surface of the outer race ring.

Write for your copy of SEALMASTER Catalog No. 845.

ZONE HARDENED
PERMANENTLY SEALED
SELF-ALIGNING • PRE-LUBRICATED
FLOATING BALL RETAINER

***ZONE HARDENING**

is a completely automatic heat treating process by which the inner race ring of SEALMASTER Ball Bearing Units is hardened through ball path section *only*. (See cutaway view.) The extended part of the inner race is left in its original metallurgically soft, tough state. Hardened set screws are mounted through this soft portion, to provide firm race-to-shaft locking and the performance advantages mentioned above. ZONE HARDENING is patented—exclusively SEALMASTER'S!

SEALMASTER BEARINGS

A Division of Stephens-Adamson Mfg. Company
9 Ridgeway Avenue, Aurora, Illinois

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

SPECIALISTS IN METAL STAMPINGS

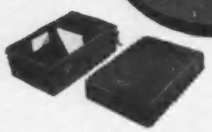
FOR OVER 70 YEARS

Base For Power Lawn Mower

G.P.&F.®

Solenoid Cover U.S. Navy

Aerial Delivery Container U.S. Air Force



Radio Case—U.S. Signal Corps

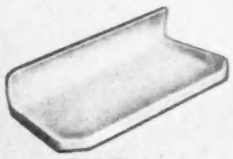
means...

Greater Production Facilities

... for your requirements of deep-drawn and stamped metal parts

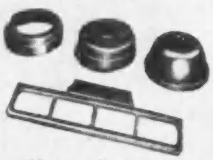
Over 1000 skilled people ... 289 deep draw and stamping presses ... 92 welding machines ... 15 acres of production facilities ... complete tool and die department.

Washing Machine Tub



Scale Platter

Safety Guard for Power Tools



Vacuum Cleaner Parts

STAMPING • DRAWING • FORMING
TINNING • GALVANIZING • WELDING
LEAD COATING • SPRAY FINISHING
VITREOUS ENAMELING

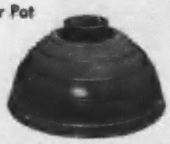
Longhorn Cheese Mold

Commercial Fruit Juicer

Deep Fat Fryer Pot

Transmitter Case

Cover for Ice Cream Freezing Equipment



Christmas Tree Stand

Fuel Tank

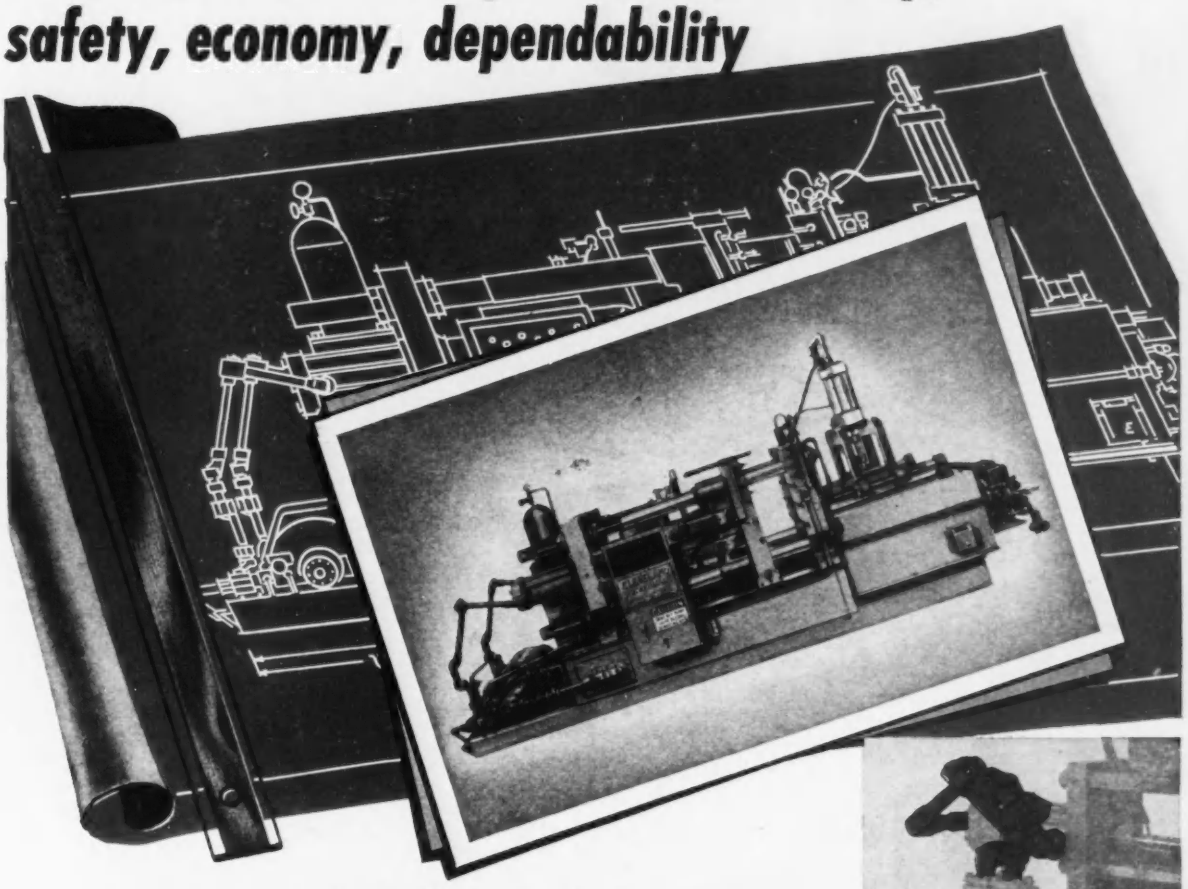
Gas and Water Cans U.S. Quartermaster

G.P.&F. SINCE 1880 MILWAUKEE

GEUDER, PAESCHKE & FREY CO.

1505 W. ST. PAUL AVENUE • MILWAUKEE 1, WISCONSIN

CHIKSAN has a blueprint for flexibility, safety, economy, dependability



CHIKSAN speeds the flow of industry when

THE DIE IS CAST

BY CLEVELAND AUTOMATIC

When industry wants better castings, faster, for lower cost it turns to the Cleveland Automatic Machine Company to furnish high pressure hydraulic die casting equipment. Cleveland is an old hand in making dependable machines that turn out precision castings to keep the wheels of industry humming.

Cleveland, in turn, relies on Chiksan Ball-Bearing Swivel Joints and Chiksan engineering to supply the flexibility, safety, dependability and economy needed in handling high pressure hydraulic oil—transforming metals to essential parts for industry's forward march.

• • • •

The whole range of industry looks to Chiksan to supply a blueprint for progress in the better, safer, more economical task of conducting liquids and gases through freely flowing lines—under great extremes of temperature and pressure—in the most difficult or complex manufacturing conditions and procedures—with uninterrupted flow—with low maintenance—with precision and profit.

• High Pressure (Chiksan) Ball-Bearing Swivel Joints on the die locking end permit adjustment of die space and insure a leakproof hydraulic system.

• High Pressure (Chiksan) Swivel Joints are standard equipment in hydraulic lines of all hot chamber machines to allow for adjustment of the shot cylinder assembly and at the same time eliminate all fire hazard.

• (Quoted from the manual that Cleveland has issued about the Model 400 Die Casting Machine—emphasizing importance of Chiksan Ball-Bearing Swivel Joints.)

The Flow of Enterprise Relies on **CHIKSAN** *Ball-Bearing Swivel Joints*

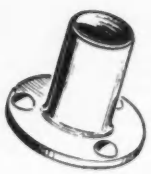
CHIKSAN TRADE MARK REG.

Representatives in Principal Cities
Write for Catalog 2A, Dept. PE-2

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey
Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

STOP

WASTING TECHNICAL TALENT



Turn over your special fastening problems to *specialists* . . . trained fastener engineers who have been through the trial-and-error stage in this highly specialized field and can free your own engineering staff for finished-product engineering.

It pays. We've proved it . . . for leading manufacturers in the automotive, electronics, aviation, appliance and furniture industries.

United-Carr and its subsidiaries have had years of experience in the design and production of *tailor-made* fasteners and allied devices. Each division of the company provides a reservoir of special knowledge for the others. The result: an integrated organization that makes use of every improvement in materials and methods to produce fasteners that *speed assembly, cut costs* and, in many cases, actually *improve product performance.*

With complete facilities in our own plants for the volume production of special metal stampings and for the assembly of metal to plastic and ceramic components, we are in a position to supply practically any fastening need.

Before bidding on government contracts requiring fasteners or special fastening devices, consult your nearest United-Carr field representative.

UNITED-CARR

MAKERS OF DOT *FASTENERS*

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

In 70 years of glassmaking, Pittsburgh Plate Glass Company has mastered the intricacies of making glass in many forms . . . has developed many techniques and new processes that have greatly increased the usefulness of glass. That's why, when it came to the relatively new art of drawing glass into tiny, tiny fibers, PPG's skilled hands took to it readily.

Pittsburgh Plate Glass Company is manufacturing Fiber Glass Superfine Insulation, and Yarns, Strands and Roving to the highest standards of the industry. But in addition to product excellence, PPG offers the experience in handling the requirements of customers which eliminates many problems that might otherwise disrupt smooth operations.

If you use Fiber Glass—or any of the materials which Fiber Glass is so rapidly replacing—investigate PPG's facilities for serving you. Pittsburgh Plate Glass Company, Fiber Glass Division, 632 Duquesne Way, Pittsburgh 22, Pa. District Offices: Chicago, Cincinnati, Cleveland, Detroit, New York, Washington.

70 years of leadership

Many of the most important developments in glass manufacture are the result of continual research by Pittsburgh Plate Glass Company. Among these diverse achievements are

—the nation's first commercially successful plate glass plant

—the origination of Hi-Test Safety Glass

—Carrara structural glass

—massive windows for atomic research laboratories

Now research is being stepped up and the glassmaking skills acquired through the years are being devoted to the making of Fiber Glass. Your business may be among those to profit first from this program—so why not consult with PPG representatives, now? Your inquiries will be welcomed.

FIBER PPG GLASS PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

JET BLACKS

Zinc plated typewriter key levers are a typical example of how the EBONOL * "Z" process provides an adherent, jet-black inorganic oxide finish to all types of zinc plated surfaces.

*Reg. Trade Mark

For blackening metals use ENTHONE EBONOLS

EBONOL "S" Processes for blackening steel to produce jet-black oxide coatings. Simple and economical to operate. Operating temperatures: EBONOL "S", 285-290°F., EBONOL "S-30", 295-305°F.

EBONOL "C" The quality black for copper and brass that meets all military specifications. Produces cupric oxide finishes that are stable, adherent and protective.

EBONOL "Z" A durable, deep, rich finish for zinc plate or zinc alloy castings. Dull or glossy oxide black coatings are formed in from 5 to 10 minutes at 160-180°F.

U. S. PATENT NOS. 2,364,993, 2,460,896, 2,460,898, 2,481,854.

Write to Enthone, Inc. for information and advice on any blackening process and ask for check list of Enthone literature on over sixty products and processes for better electroplating and metal finishing.

METAL FINISHING PROCESSES

ENTHONE
INCORPORATED

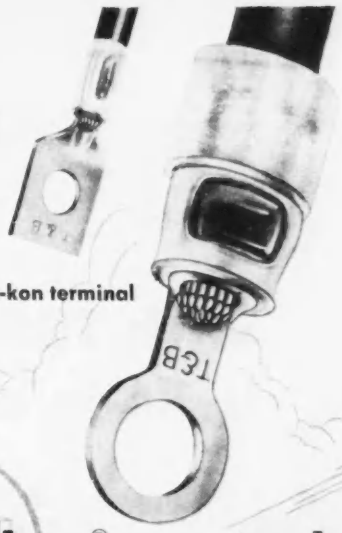
ELECTROPLATING CHEMICALS

442 ELM STREET
NEW HAVEN, CONNECTICUT

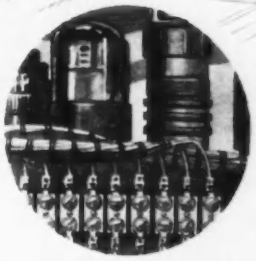
T&B ENGINEERED

Sta-kon terminal

Self-insulated Sta-kon terminal



How T & B Sta-kon® terminals add permanence to any wiring hook-up



1. Sta-kon terminals provide sure, certain connections

An electronic brain can work miracles — yet a single loose connection can upset its accuracy. Offering far greater uniformity than possible with solder, insulated T & B Sta-kon terminals make fast, permanent connections of low resistance — even at extremely low currents. The integral nylon insulating sleeve minimizes possible accidental shorting across crowded terminal blocks. Color-coded, insulation can't slip loose . . . withstands heat, cold, and many chemical agents.

2. . . . are safe and easy to install

No flame, heat, or fluxing agents are required to install Sta-kon terminals — there's no danger of explosion or corrosion . . . no damage to insulation. Just a single operation with T & B Shure Stake tools stakes terminal to solid or stranded wire with terrific pressure . . . compresses them to a near-solid mass. Fool-proof tool operation assures connections that won't vibrate loose . . . can't fail under severe stresses.

3. . . . are available as a complete line —including "specials"

The T & B line of Sta-kon terminals and connectors is designed to meet almost every wiring need: wire sizes 22 to 4/0; in varied tongue styles and stud sizes; with and without insulation grip. Among the "specials" available is this heater wire terminal. Ideal for connecting all types of resistance wire, these heat-resisting terminals add extra life to any toaster, iron, or heater.

For full details on T & B Sta-kon terminals and connectors, make it a point to write for Bulletin #61.

LOOK FOR THIS SIGN — T&B ENGINEERED

IT'S THE MARK OF AN AUTHORIZED T & B DISTRIBUTOR

The complete line of T & B fittings for conductors and raceways is sold only by recognized electrical wholesalers. It's our way of assuring you the service and savings of a friendly local source. Call him for all your electrical needs.

THE THOMAS & BETTS CO.

INCORPORATED

16 Butler Street • Elizabeth 1, New Jersey

Thomas & Betts Ltd., Montreal, P.Q., Canada

MANUFACTURERS OF FINE ELECTRICAL FITTINGS SINCE 1898

tiny to
giant-sized bearings

with TEAM-WORK built-in every size

With every size in SKF's wide range of ball and roller bearings, you receive an extra quality—*team-work*. This is the ability of SKF field and home office engineers to cooperate productively with your equipment designers. Helping to solve their bearing problems is the *extra* which all industries have learned to expect from SKF.

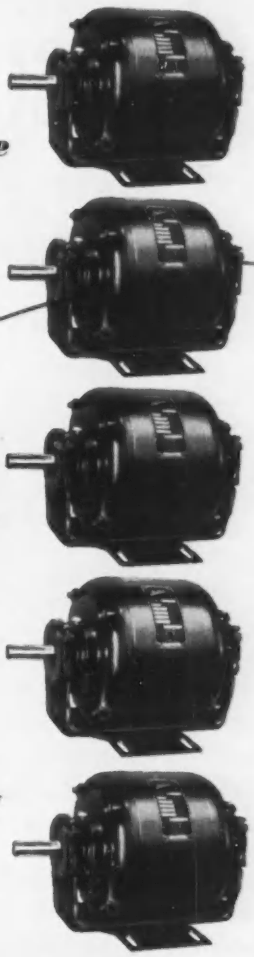
SKF
BALL AND ROLLER BEARINGS

7303

SKF INDUSTRIES, INC., PHILA. 32, PA.— *manufacturers of* **SKF** *and* **HESS-BRIGHT** *bearings.*

year in . . . year out . . . more and more appliance manufacturers turn to

PACKARD ELECTRIC MOTORS



for:

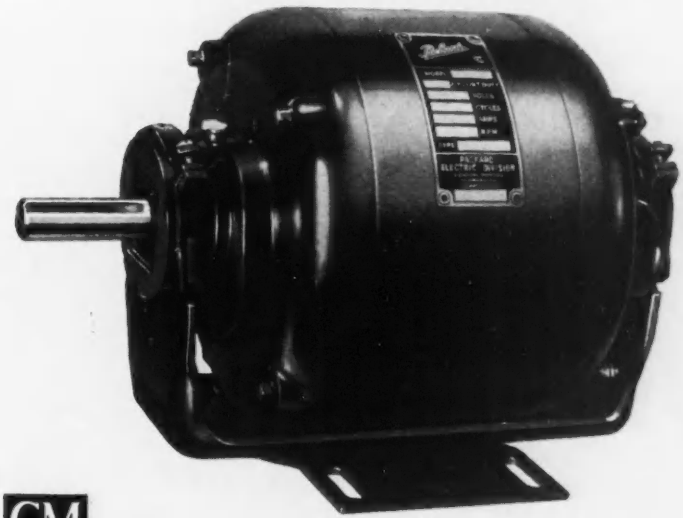
DRYERS
WASHERS
IRONERS
WATER PUMPS
LAWN MOWERS
OIL BURNERS
BLOWERS
VENTILATING UNITS
STOKERS
DISPOSAL UNITS
BENCH TOOLS
COMPRESSORS
MILKING MACHINES
CREAM SEPARATORS

Manufacturers who produce motor-powered products in volume know from experience the advantages of using motors of Packard Electric. A motor especially adapted to the product fits better in the space available . . . provides correct starting and operating torques . . . is built to stand up on the job.

If you manufacture a motor-powered product, Packard Electric engineers can help . . . can design the motor that will assure you of satisfactory product performance for your customers. And Packard Electric, with its tremendous facilities, can mass produce the motor for you—at low cost.

That's why we suggest you talk with Packard Electric about any motor problem. Packard can provide the right motor for you.

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS



GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors Corporation
Warren, Ohio

"...in the customer's corner"

You hear people say: "He is a good salesman, he takes care of his customer." By this is meant that the salesman uses his special knowledge, his influence with his employer, and his time and effort to help the customer get what he wants, be it products, information, technical data, terms or other extraordinary services.

The Bunting organization through constant research, development of new equipment, and modernization of all production operations provides Bunting salesmen with the means of serving as well as selling. Ask any Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

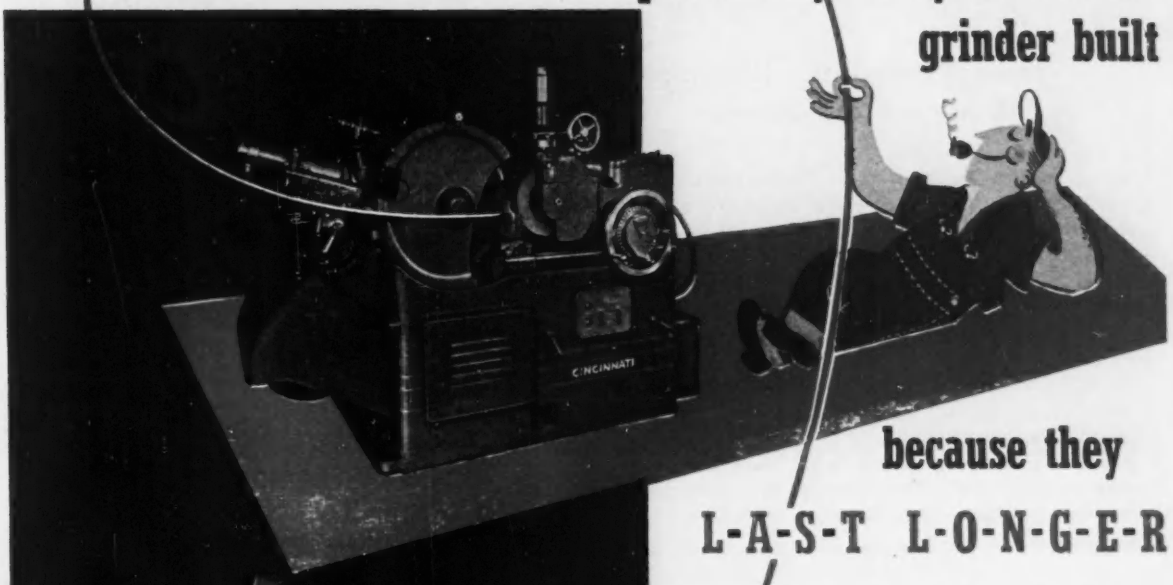
Bunting

BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS

THE BUNTING BRASS & BRONZE COMPANY • TOLEDO 1, OHIO • BRANCHES IN PRINCIPAL CITIES

OK CENTERLESS BLADES

. . . standard equipment on practically every centerless grinder built



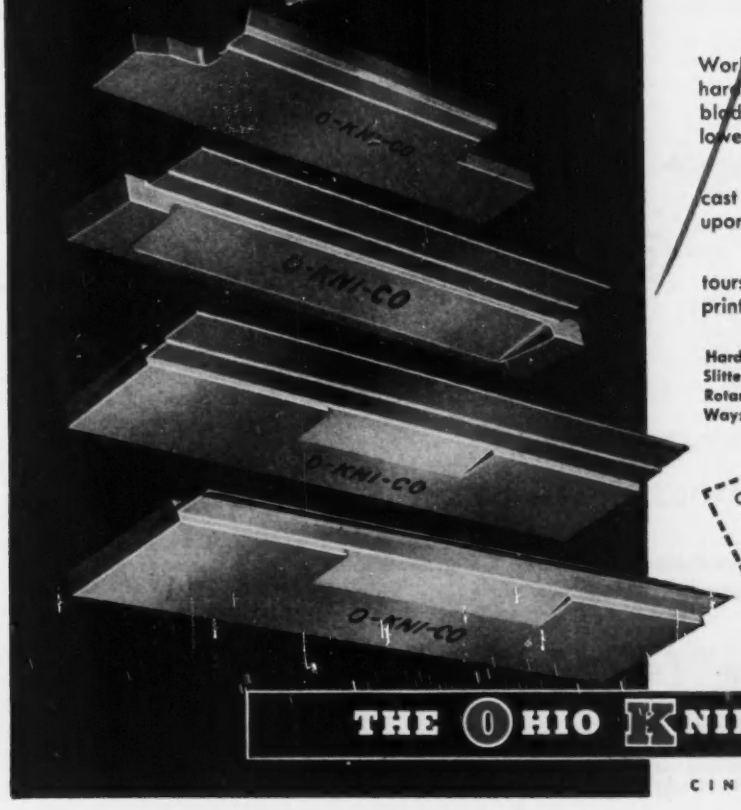
because they

L-A-S-T L-O-N-G-E-R

The phenomenal long life of Ohio Centerless Work Blades and Guides is due to their extreme hardness, high finish and close tolerances. Long blade life means high production resulting in lower costs.

Made of tungsten carbide, high speed steel, cast alloys or iron. Non-metallic tips available upon request.

In addition to standard blades, special contours, angles or shapes are made to your blue prints.



Manufacturers of
Hardened Spacers, Ways, Gibs, Ball Races, Slitter Knives, Shear Blades, Rotary Shear Knives, Bronze Ways, Wear Strips.

OHIO KNIFE CO. DEPT. 8
CINCINNATI 23, OHIO
Please send free Bulletins on OK Centerless Blades, etc.

NAME
COMPANY
ADDRESS
CITY STATE

GO WITH OHIO GREEN

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

SELF-LOCKING "PLACE" BOLTS

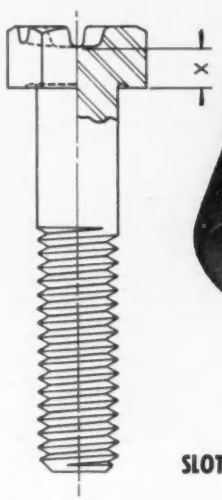
...cut costs...add strength

. . . wherever involuntary loosening or fatigue are a problem!

In some typical automotive and farm equipment applications, for instance, "Place" Bolts are being used as connecting rod bolts, main bearing cap screws, and flywheel bolts.

Here, and wherever a locking bolt may be needed, the Slotted-Type "Place" Bolt offers not only positive locking action but economy and additional strength. It cuts costs because no additional parts or operations are needed. It adds strength because its controlled spring action guards against impact, shock and fatigue failures.

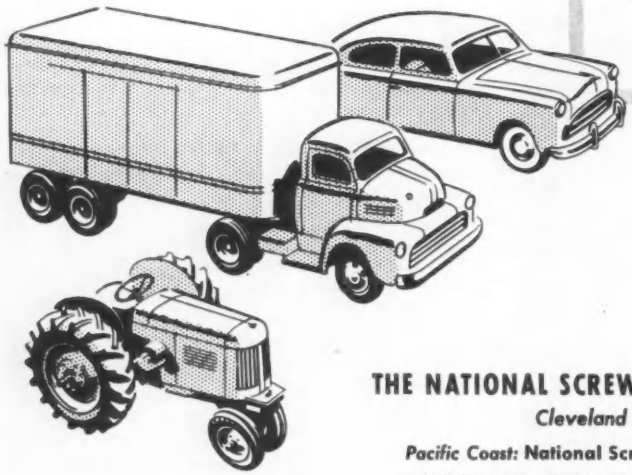
National makes the Slotted-Type "Place" Bolt in carbon or alloy steel, in any of a wide range of sizes. Write us for additional information, including our illustrated folder.



HERE'S HOW SLOTTED-TYPE HEAD LOCKS

The flexible diaphragm formed between slotted segments in the upper face of bolt head and circular recess adjacent to the shank in lower face (section X) acts as controlled spring element when head is properly wrenched against a rigid seat. Diaphragm is reinforced by the continuous-grained segment cold formed between upset slots in upper face.

U. S. Patent No. 2543705



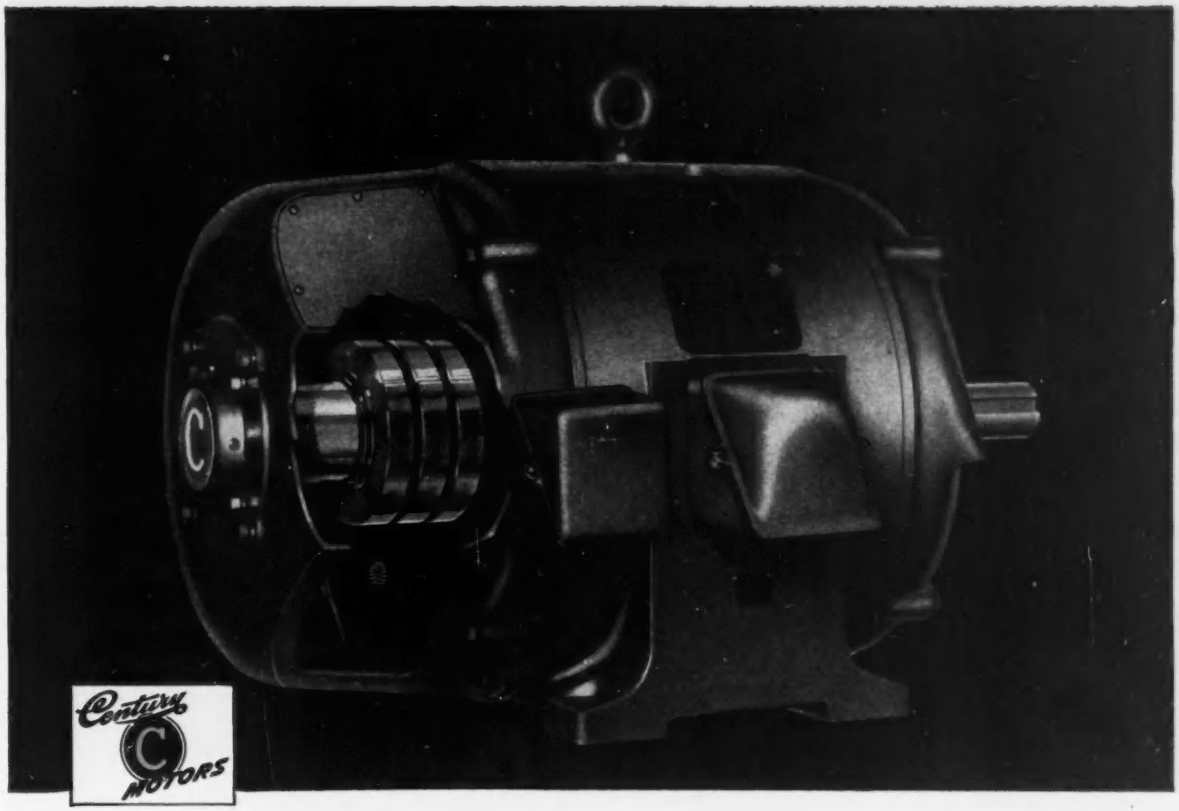
THE NATIONAL SCREW & MFG. COMPANY

Cleveland 4, Ohio

Pacific Coast: **National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 23, Cal.

National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS



perfect contact at high speed

Through Advanced Casting Techniques, We Help Our Customers to Better Serve Their Customers.

Bronze collector rings, like these, are important power transmission factors in electric motors—such as those produced by Century Electric Company, St. Louis, Missouri. Making high speed revolutions with the armature, collector rings must be perfect, as sand inclusions, pits, or other flaws cause arcing, with subsequent loss of motor power.

Century Electric Company, leading manufacturer of quality electric motors, generators, and related equipment, was aware of National Bearing Division's outstanding reputation for quality copper-base castings, using advanced foundry techniques and mass production.

Century was confident we could produce, as specified, flawless bronze collector rings for use in their products.

And their confidence was justified.

Our modern, centrifugal, permanent mold technique enables us to exactly meet Century Electric's specifications. This advanced foundry method eliminates sand molds for castings such as these. The bronze is tough and dense, and rings are cast close to size, minimizing machining. And Century enjoys dollar savings through our production-run economies.

Most important to them, however, is the fact that they are now providing their customers with equipment that includes collector rings of the highest quality.

If your product requires precision-cast bronze or other copper-base components, it will pay you to investigate National Bearing Division. We produce copper-base castings, large or small, with or without machining. And our production-run economies will probably save you money.

Write National Bearing Division for full information and your copy of our catalog.

AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION

4932 Manchester Avenue • St. Louis 10, Mo.

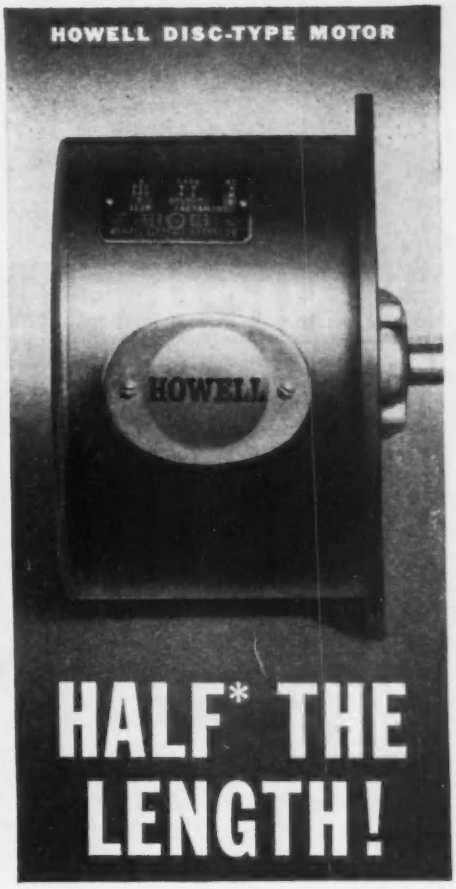
PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

- Made to your design and production requirements with high-production equipment.
- Continuously formed from carbon, galvanized or stainless steel, aluminum, copper, zinc and cladmetals.
- Available in 6-inch to 24-ft. lengths.
- Deliveries when and where you want them.

Roll Formed engineers are constantly devising new methods and processes for metal forming. Consult them regarding your requirements. Send prints or parts for prompt quotation. *Write for the new Roll Formed Catalog RF 1053.*

ROLL FORMED PRODUCTS
COMPANY

MAIN OFFICE AND PLANT
3760 OAKWOOD AVENUE **YOUNGSTOWN, OHIO**



* Depending on horsepower, reduction in length ranges from 41.7 to 50.5%!

Compact motor design offering wide range of sizes (from ¼ to 20 h.p.) and variety of electrical types presents positive advantages to machine designers and electric motor buyers!

Here's something really unusual in electric motor design! A motor-type that delivers the same power, has the same characteristics as conventional motors . . . yet its length has been *cut* by as much as *one half!* It's the Howell Disc-Type Motor!

The comparison above shows the drastically reduced length of the Disc-Type Motor as against a conventional motor of the *same horsepower*. The shorter length is achieved by flattening the end plates and moving the ball bearings back into the motor. *Every other feature of rugged, precision-built Howell Motors is retained.*

The Disc-Type Motor is available in your choice of horsepower, frame sizes, mountings, electrical characteristics; you may have open or totally enclosed types, single or polyphase, with integrally-mounted brakes if desired.

These space-saving motors have proved successful in dozens of main-drive and auxiliary applications where space is at a premium. They are particularly suitable for cranes, hoists and rapid traverse drives. Call the Howell representative in your city for expert assistance in applying Howell Disc-Type Motors to *your* machines. For a free technical bulletin giving specifications, clip and mail the coupon today.

WIDE RANGE OF SPECIFICATIONS

1. Sizes from ¼ to 20 h.p. at 1800 r.p.m. including intermittent hoist types. Corresponding ratings at other speeds also available.
2. Open or totally enclosed types.
3. Electrical characteristics—NEMA designs A, B, C and D, as well as elevator and torque motor types.
4. Foot or flange mountings.
5. Frame sizes A-56 to A-326.
6. Integrally-mounted brakes if desired.

HOWELL ELECTRIC MOTORS COMPANY
Howell, Michigan

Please send me a free copy of the technical bulletin on Howell Disc-Type Motors.

Name_____

Firm_____

Address_____

City_____ Zone_____

State_____

HOWELL Red Band MOTORS

HOWELL ELECTRIC MOTORS CO.

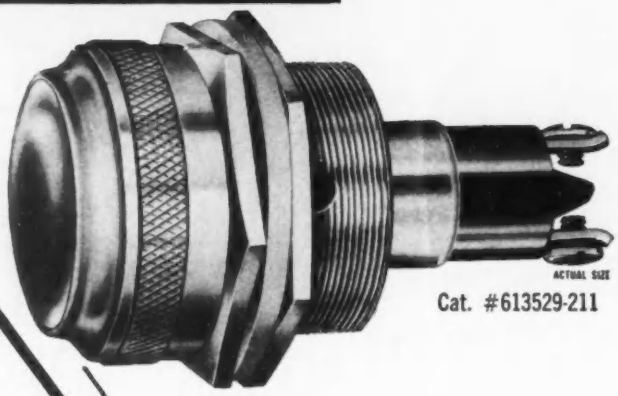
HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO



Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

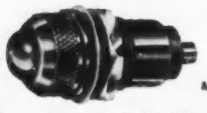
or

this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

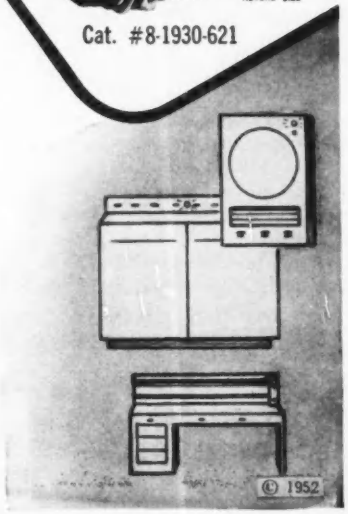
THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.



Cat. #8-1930-621

Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.



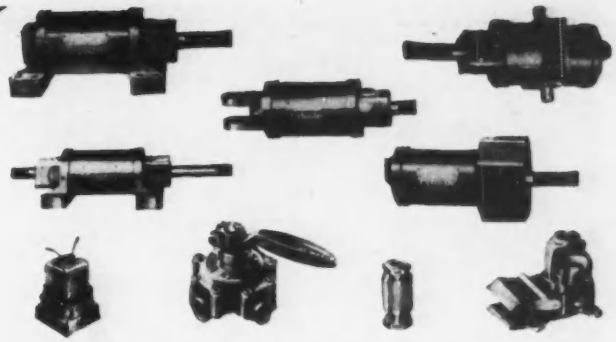
Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. HYACINTH 7-7600

one answer... HANNA for all three...



labor-saving cylinder power

Standard Hanna Cylinders—
Matched to the Job!

A choice of hydraulic and pneumatic cylinders to match your power and mounting requirements . . . to improve control and operation of machines and equipment . . . to replace or reduce manual operations. Hanna Valves provide hand, foot, cam or pushbutton actuation; manual, semi-automatic, full automatic or remote control operation.

money-saving engineering

Nation-wide, on-the-spot
Sales and Engineering Service!

Hanna experts in cylinder power applications are always ready to help you select the best cylinder and valve combination for your special requirements, to see that you get the most value from your cylinder dollar.

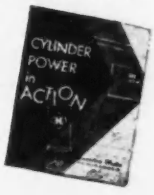
time-saving delivery service

Planned Production Scheduling
Assures Prompt Delivery!

Hanna Sales Representatives located in principal cities throughout the U.S. and Canada can give you **less than three weeks' delivery** on Hanna Cylinders. They carry a stock of Hanna Valves for immediate delivery.

The Hanna name is your assurance of quality. It is backed by over 50 years of specialization on cylinders and control valves. It means economical cylinder power, dependable engineering help and prompt delivery. See your Classified Directory or your Hanna Catalog for the name of **your local representative**. He is ready to **help you solve** your power motion problems. Call him today!

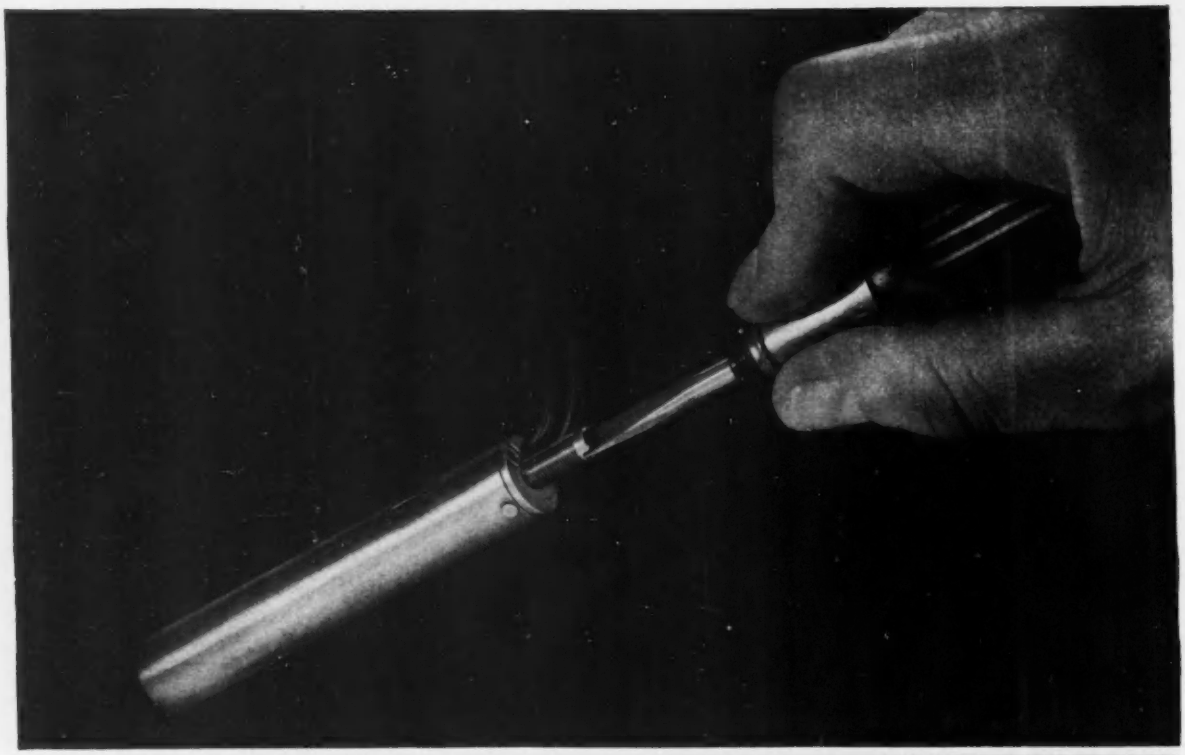
Write for free copy of new Bulletin 255 showing Hanna Cylinder Power in Action!



Hanna Engineering Works

1763 ELSTON AVE. • CHICAGO 22, ILL.

HYDRAULIC AND PNEUMATIC EQUIPMENT...CYLINDERS...VALVES...RIVETERS



The Superior Tube That Keeps Cool in a Hot Spot

Cooling off customers' hot problems is a Superior specialty.

An example is illustrated above. The customer, Fenwal, Incorporated of Ashland, Massachusetts, manufactures THERMOSWITCH® industrial thermostats; Aircraft temperature controls, fire and overheat detectors; DETECT-A-FIRE® fire detectors. All of these products use stainless steel tubing. Before consulting with us an extra machining operation on the inside diameter was required. The tubing used needed a special temper for softness.

Problems like this one are tailor made for Superior. We produced for Fenwal a tube with a smooth, clean, almost mirror-like inside finish to eliminate the need for the extra machining operation. We were able to do this while still maintaining the low physicals necessitated by a stress cracking possibility.

What's more, the finished product was not a "specialty" tube. Our long experience in fine small tubing, backed by highly developed production equipment and extensive research and testing facilities enables us to produce tubing to the strictest specifications in large quantities. If you have a production problem involving the use of top-quality small tubing to do tough jobs well, check with us. We can probably supply you from the stocks of our distributors who are located in principal cities. Write for Catalog #20, Superior Tube Company, 2012 Germantown Ave., Norristown, Pennsylvania.

BE SURE ABOUT TUBING— SPECIFY

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O. D.
Certain analyses (.035" Max. wall) up to 1⅜" O.D.

ROUND AND SHAPED TUBING

Available in:

Carbon Steels:
A.I.S.I.—C-1008, MT-1010, MT-1015, C-1118, MT-1020, C-1025, C-1035, E-1095.

Alloy Steels:
A.I.S.I.—4130, 4132, 4140, 4150, 8630, E-52100.

Stainless Steels:
A.I.S.I.—303, 304, 305, 309, 310, 316, 317, 321, 347, 403, 410, 420, 430, 446, T-5.

Nickel Alloys:
Nickel, "D Nickel"*, "L Nickel"*, "Monel"*, "K Monel"*, "Inconel"*, 30% Cupro Nickel.

Beryllium Copper

West Coast: Pacific Tube Company, 5710 Smithway, St., Los Angeles 22, Calif. UNderhill 0-1331.

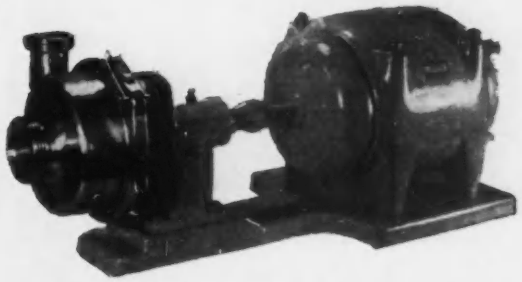
*Reg. U. S. Trademark International Nickel Company

Here are the PUMPS that will handle ANY PRODUCT that will flow to them . . .

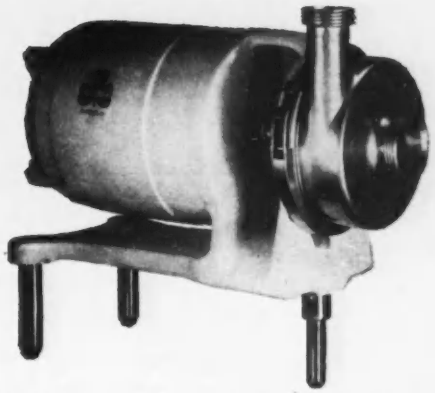
ANY product that will flow to them can be handled efficiently and economically with Tri-Clover non-agitating centrifugal pumps. Illustrated are three of the many Tri-Clover pump models which are used for dairy and food processing, brewing and bottling, chemical and general industrial applications.

Designed for efficient liquid transmission and low cost maintenance, these pumps feature patented screw type impellers with sanitary impeller clips, inert carbon seals easily removed for cleaning, streamlined lightweight heads with a minimum of parts, and the exclusive Tri-Clamp casing construction which permits fast, easy pump assembly or disassembly.

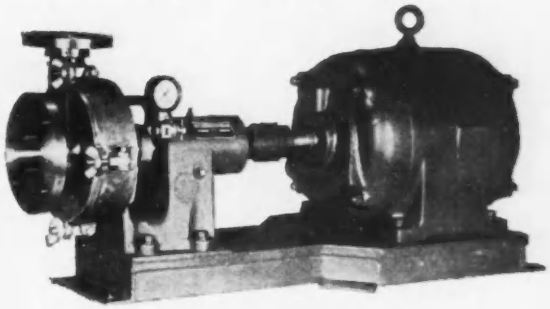
Tri-Clover's exclusive developments are the result of over 30 years of specialized engineering experience and thorough knowledge of liquid handling. Let our engineering staff work with you in solving your pumping problems.



This model has been designed for the non-agitating, efficient pumping of milk, food products such as diced carrots, cream style corn, tomatoes, applesauce, relish and beverages. It is also practical in breweries and for the pumping of drugs and chemicals in solution.



Designed for very efficient operation at 1800 and 3600 RPM, and especially where high speeds are required, through heaters, coolers, filters, clarifiers, etc. The 3600 RPM model is especially applicable in the dairy industry, where high head and low capacity are essential and for handling low and medium viscosity liquids in the food processing industry.



Here is the model that is in demand to pump Latex, water, brine, light oils, chemicals, paints, brewery products, and liquids in the food processing field where lines are of heavy I. P. S. type. This model offers quick disassembly features for ease in cleaning.

EXPORT DIVISION: 8 South Michigan Avenue
Chicago 3, Illinois, U. S. A.

SEND FOR THE TRI-CLOVER PUMP CATALOG—*One of the most complete, useful pump catalogs ever compiled. Contains engineering data on all types of pump applications. Write for your copy of Catalog 250 today.*

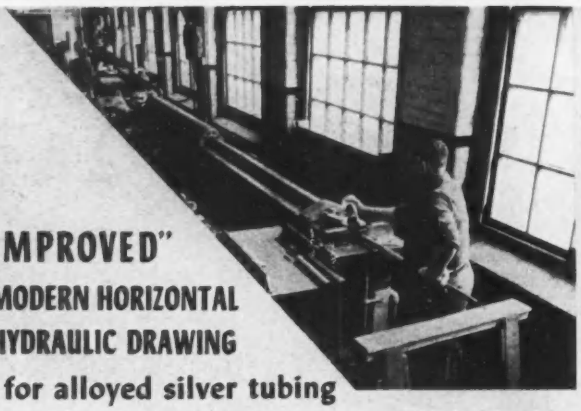
Tri-Clover®
MACHINE CO.
Kenosha, Wisconsin

TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

THE Complete LINE

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

P152

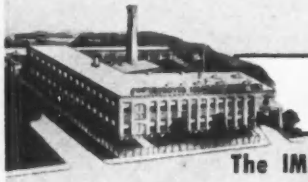


"IMPROVED"
MODERN HORIZONTAL
HYDRAULIC DRAWING
. . . for alloyed silver tubing

This improved modern equipment assures faster production and more accurate tubing in sizes up to one inch. Alloyed silver or composite metals are custom-made to your specifications. Tolerances ± .001 inside and outside diameters. Please write for further information on the many industrial uses of "Improved materials."

Your product name plate deserves to be made of "Improved materials."

SEE OUR BOOTH #215 AT BASIC MATERIALS EXPOSITION IN JUNE



The Home of IMPROVED Service
Rhode Island's largest manufacturer of Laminated Metals.

The IMPROVED SEAMLESS WIRE COMPANY
INCORPORATED 1898
775 Eddy Street, Providence 5, Rhode Island

decco
INDUSTRIAL SOLENOIDS

Specified by the country's largest users of solenoids.

Shock-mounted for longer life. Designed to meet J. I. C. specifications.

Four to 20 pounds push or pull. Stroke to one inch maximum. A. C. and D. C. models.

Special solenoid problems engineered to your needs.

DETROIT COIL COMPANY
2435 HILTON ROAD • DETROIT 20, (FERNDALE) MICHIGAN

How to Boost Sales Through Better Product Identification

8 pages — 25 cents a copy

Because even the best and most attractive product will sell better when it is attractively and eye-catchingly labeled, design engineers are increasingly aware of the importance of attractive nameplates escutcheons, and instruction plates. All can be accentuated by proper treatment to give your product increased brand recognition and sales appeal.

This comprehensive report on contemporary methods and processes for better product identification, "Identifying Your Product," is one of *Product Engineering's* series of full-color articles covering product improvement through better surface appearance, protection, and identification.

Copies of other reports in this series are also available.

WHICH COATING FOR GRAY IRON?
8 pages — 25 cents a copy

ELECTROLYTIC AND CHEMICAL COATINGS
8 pages — 25 cents a copy

TEXTURED ORGANIC COATINGS
8 pages — 25 cents a copy

HOW TO PLAN PRODUCT COLORS
8 pages — 20 cents a copy

PORCELAIN ENAMEL COATINGS
8 pages — 20 cents a copy

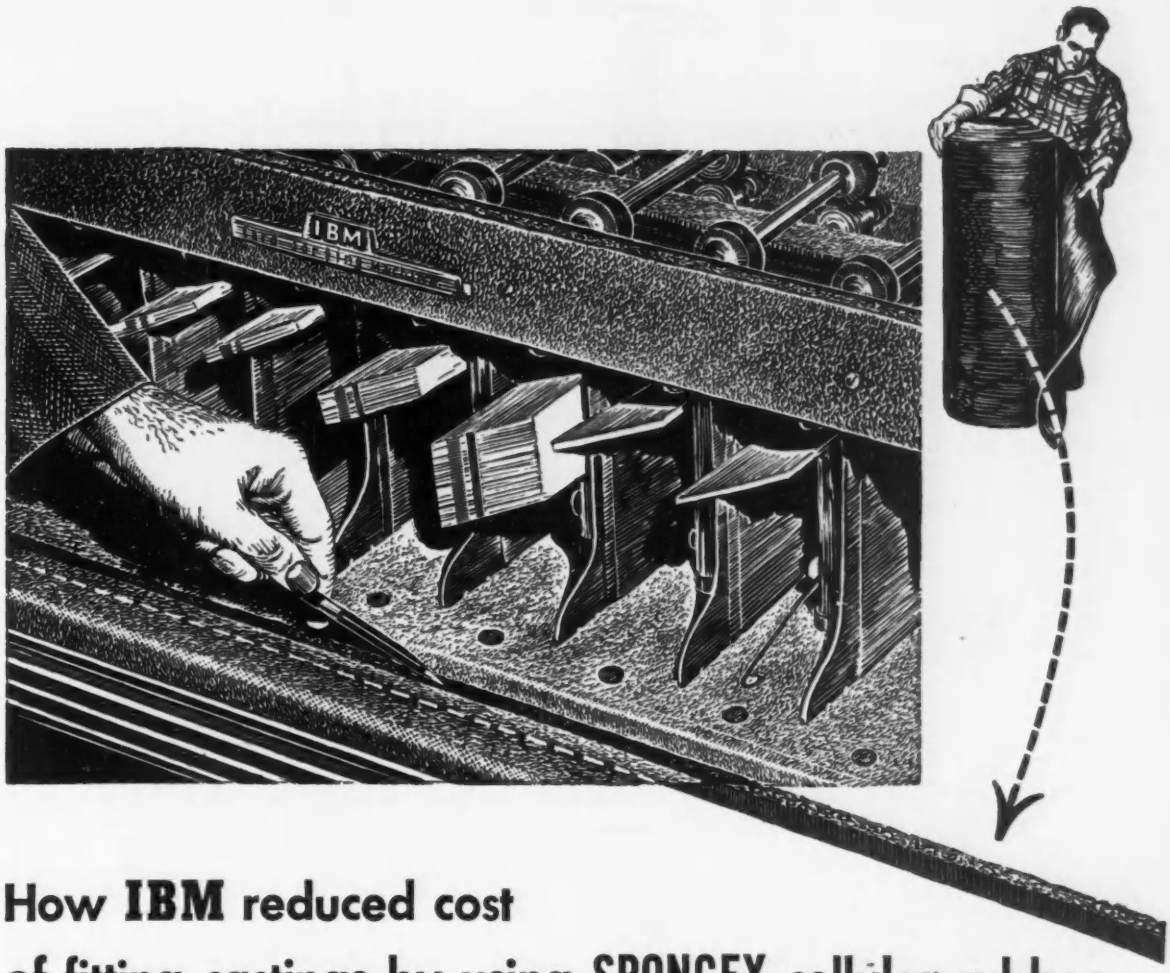
FINISHES FOR ALUMINUM PRODUCTS
8 pages — 20 cents a copy

SELECTING ORGANIC COATINGS FOR METAL PRODUCTS
8 pages — 15 cents a copy

PHOSPHATE COATINGS FOR MILITARY PRODUCTS
8 pages — 25 cents a copy

WRITE TO READER SERVICE DEPARTMENT:

Product Engineering
McGraw-Hill Building,
New York 36, N. Y.



How IBM reduced cost of fitting castings by using SPONGEX cellular rubber

To get a perfect fit between the base casting and the apron on this card sorter, could be an expensive machining and fitting job. Instead IBM used an inexpensive strip from Spongex sheet stock to economically and successfully compensate for the surface variations of these metal parts.

Many production problems can be solved just as easily with an inexpensive form of Spongex. Gasketing, vibration damping, sealing, shock absorption . . . are only a few of the hundreds of applications of Spongex sheet stock.

You might cut your own needs from Spongex sheets and rolls. Or we'll die-cut to your specifications. If you want flame resistance, oil resistance, low temperature performance or high . . . there's a Spongex sheet stock compounded for the job.

SPONGEX® Cellular Rubber

for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 602 Derby Place, Shelton, Conn.

No grid, no ghosts appear on your prints!

CLEARPRINT CALCULATION AND SKETCHING SHEETS

with cross sections printed in "Fade-Out" blue

Quick calculations and sketches to scale are easy with Clearprint "Fade-Out" sheets. They're printed on No. 1000H Clearprint, America's finest technical paper. Ask for a sample and make this convincing test...

1. **INVITES THE PENCIL** – Try Clearprint's perfect working surface with a 2H pencil. Your lines are sharp and clean—no feathery edges.
2. **ERASES PERFECTLY**—Erase some of the lines. Redraw and erase several of them time and again. Fold the paper repeatedly, too. Then hold it to the light and notice the absence of ghosts and grid lines.
3. **GHOST-FREE, GRIDLESS REPRODUCTIONS** – Make a quick, easy-to-read print of the sheet. Your original work is faithfully reproduced without erasure ghosts or cross section rulings.

If you are not using Clearprint now, please make this comparative test on the paper you are using.

CLEARPRINT®

PRINTED WITH FADE-OUT BLUE LINES

Available in standard size pads and sheets through 24" x 36".

Ask your dealer for samples, or write:

CLEARPRINT PAPER CO.

1482 SIXTY-SEVENTH STREET · EMERYVILLE, CALIFORNIA

RIGID-tex METALS put IMAGINATION into your designs

■ it takes imagination to put into your product all the benefits your customers want... and that's where Rigid-tex Metals come into your product picture. every sheet or strip of Rigid-tex Metal has clear-through pattern design... as much as 108% greater rigidity... 70% greater buckling strength... 39% greater impact resistance... 92% greater tensile strength! and what's more, Rigid-tex Metals can be used for nearly every product under the sun!

send for your Design Imagineering Folder... on company letterheads, please.

RIGID METALS **RIGIDIZED METALS CORPORATION**

6732 OHIO STREET BUFFALO 3, N. Y.

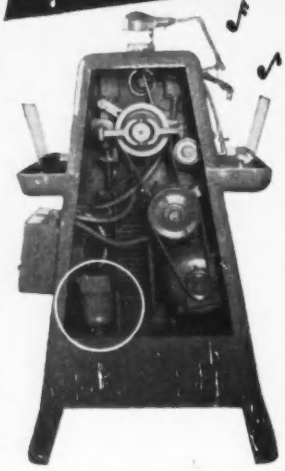
50 Warehouses and Sales Representatives in All Principal Cities Throughout the U. S. and Canada

U. S. & Foreign Patents

3-PART HARMONY

in your cutting operations with your

RUTHMAN GUSHER COOLANT PUMPS



Your Gusher gives you—

1. **ECONOMY**—Uses less power when throttled—requires less attention—
2. **LONG LIFE**—Simple design—electronically balanced rotating parts—precision construction, assures long life.
3. **EFFICIENCY**—Responds instantly with copious coolant flow.

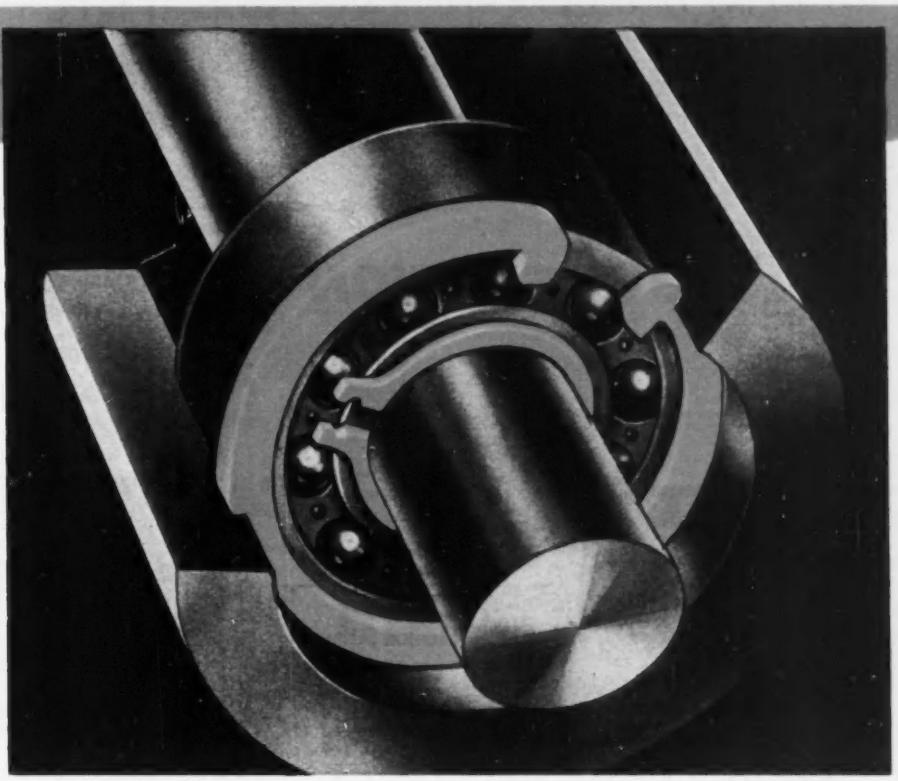
For a better coolant pump specify Gusher Pumps on your metal cutting machine.

This Superior Honing Machine is equipped with a Ruthman Gusher Pump—Follow the leader; specify Ruthman on your machine.

THE RUTHMAN MACHINERY CO.

1818 READING ROAD CINCINNATI, OHIO

•Save Time •Save Materials •Save Money!



Examine the designs of **all** your products and machines. No doubt you can use retaining rings on axles and in housings – not **only to save assembly time, but to save weight, parts and space.**

The use of these inexpensive yet efficient artificial shoulders is already widespread, and is increasing daily.

There are literally thousands of places in which redesigning for retaining rings can increase your profits and improve your products – uses ranging from heavy duty engines and drill presses to toys, gadgets and small parts of innumerable articles.

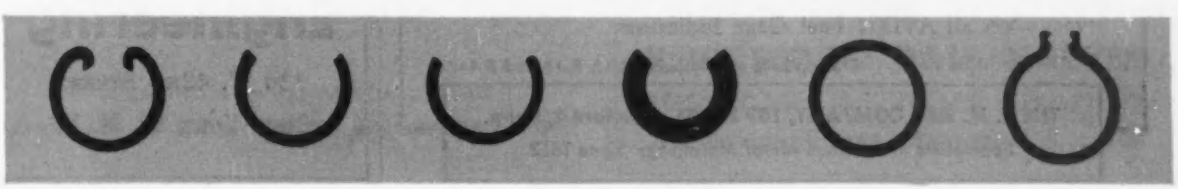
It's wasteful to cut down shafts to make shoulders. Redesign to groove smaller shafts and housings and use these high grade steel rings.

Let our engineers consult with you. Send for folders.

Don't pass up this opportunity to increase profits.

THE NATIONAL LOCK WASHER CO.

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN



MULTIPLE ASSEMBLIES FOR SMALL PARTS
BELONG TO HORSE-AND-BUGGY DAYS

GRIES DIE CASTINGS GIVE YOU
TINY PARTS LIKE THESE IN

COMPLETE OPERATION

Compare GRC zinc alloy die castings with small parts produced by other methods. See how Gries completely finished parts save you time, labor, money. Die cast in one high-speed operation, they open broad opportunities for your new design and product ideas. GRC offers fast delivery of 100,000 pieces to many millions. Write today for bulletin and samples. Send prints for quotations.

America's Foremost PRODUCERS of Tiny Die Castings

Smallness Unlimited
Max. Wt. ½ oz.
Max. Lgth. 1¾"

GRIES REPRODUCER CORP.
Manufacturers of Small Castings EXCLUSIVELY
98 Willow Ave., New York 54. MOtt Haven 5-7400

NEY'S SMALL PARTS PLAY A **BIG** PART IN PRECISION INSTRUMENTS

NEY slip rings are used very satisfactorily on all AVIEN Fuel Gage Indicators.

Do you have our Bulletins R-12, R-13, and R-14?

THE J. M. NEY COMPANY, 109 Elm St., Hartford 1, Conn.
Specialists in Precious Metal Metallurgy Since 1812

1SMYB2A

WANT MORE INFORMATION *about*

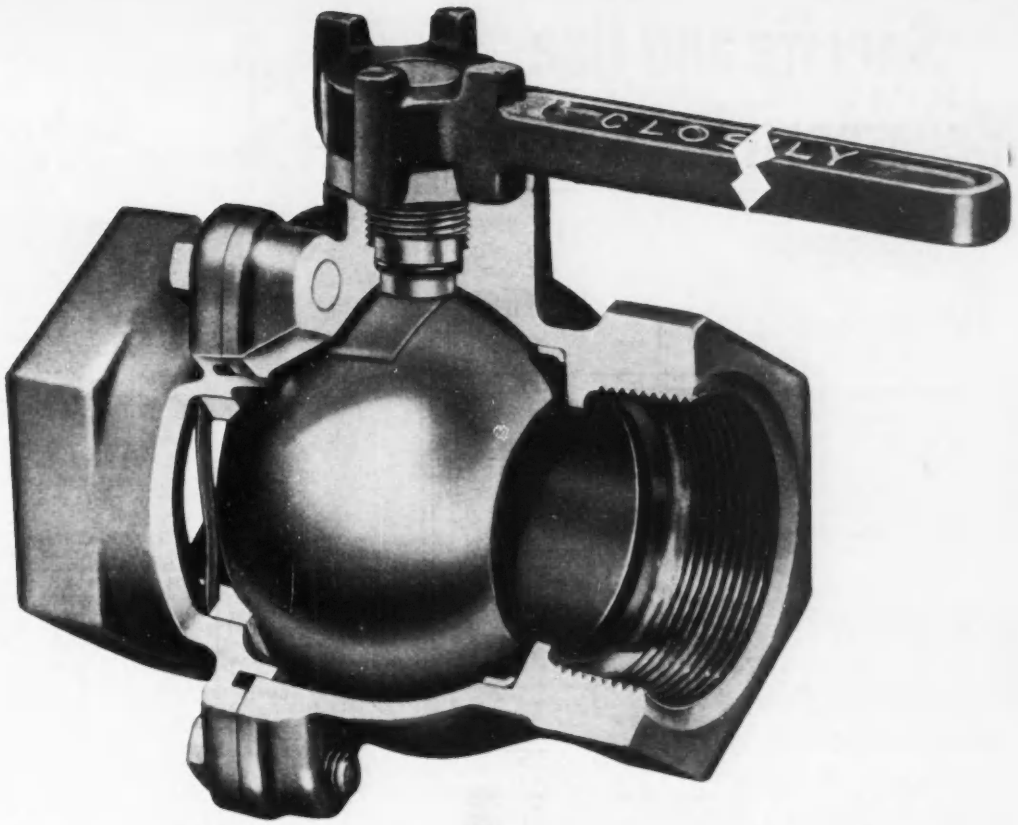
PARTS
MATERIALS
SUB-ASSEMBLIES
or
FINISHES?

Chances are you will always find in **Product Engineering's** "New Catalogs and Bulletins" insert several listings offering literature which will supplement the articles and advertisements which are of greatest interest to you.

So, each month, be sure to check through the "New Catalogs and Bulletins" and send us your requests. Without cost to you, we'll see to it that the manufacturers concerned receive your requests promptly.

•

Product Engineering
330 W. 42ND STREET
NEW YORK 36, N. Y.



NEW BALL VALVE

gives you more of what you want in a valve

Full round flow . . . as full as if there were no valve in the pipe at all. Handles fluids with minimum friction loss . . . without turbulence.

Quick opening . . . Quick closing . . . even under full pressure. Needs only an easy quarter turn.

Resists wear longer . . . chrome-plated floating bronze ball is extremely resistant to scratching, pitting, abrasion.

Stays leakproof . . . When valve is in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

DISTRIBUTORS IN ALL PRINCIPAL CITIES

APPROVED BY UNDERWRITERS' LABORATORIES, INC.

Among the many satisfied users of Rockwood Ball Valves are:

Libbey-Owens-Ford Glass Company
Revere Copper & Brass Incorporated
Bird Machine Company
Remington Rand, Inc.
Hub Machine Company
Daggett Chocolate Co.
G. F. Heublein & Bro., Inc.

Send For Free Bulletin, "New Rockwood Ball Type Valves," containing detailed information.

ROCKWOOD

ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY

106 Harlow Street, Worcester 5, Mass.

Specify and Use Meyercord Decals to...

warn

CAUTION

O NOT STAND HERE AT ANY
ME WHILE CLUTCH IS ENGAGED
ND BALER IS OPERATING.

BEFORE LOADING
1. Set Hot Water Tank 140 in advance
2. Set Washer Temperature
3. Turn on Washer for ONE
4. Spin Out Cold Water

instruct

identify

Bendix
AUTOMOTIVE
CTRIC FUEL PUMP
MODEL NO. 476089
6 VOLTS POS. GROUND
U.S. PATENTS
2458770, 2472067, 2533164,
OTHER PATENTS PENDING
ECLIPSE MACHINE DIVISION
BENDIX AVIATION CORPORATION
ELMIRA N Y U S A

Investigate the Low Cost, High Speed Application of these Durable All-Color, All-Surface Meyercord Decals...

Among the many new applications of decals for American industry is the tough Meyercord acid, chemical and weather resistant identification of dangerous chemical containers. Whether to comply with state requirements or to strengthen your voluntary safety program... if you process and ship dangerous chemicals, be sure to ask for full information on this important feature.

You know, of course, that Meyercord Decals have been adopted by cost-conscious manufacturers in thousands of industries . . . as nameplates, trademarks, instructions, markers, wiring diagrams, safety warnings and many other important applications.

But "just any decal" won't do the job on "just any surface". For today's rigid requirements Meyercord Decals are carefully laboratory-engineered to assure complete and perfect adhesion to any commercial surface or finish. Meyercord experience pays off every time. Write us for information on our complete technical consultation and designing services.

Send for This Manual of MEYERCORD DECAL NAMEPLATES

Shows hundreds of uses for durable, washable decal nameplates . . . as trademarks, instructions, charts or diagrams—in any size, colors, or design. Tells how Meyercord Decals can help you cut costs and speed production. This manual is FREE . . . request it on your business letterhead, please.

THE MEYERCORD CO.
World's Largest Decalcomania Manufacturers
DEPT. B-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

NORTH AMERICAN USES

Lube-Lok
Bonded to Metal Lubrication
ON
FLAP TRACKS

Lube-Lok fights friction on North American's FLAP TRACKS... provides lubrication at critical low temperatures encountered at high altitudes.

Every day Lube-Lok solves critical lubrication problems for aircraft industries, armed services, etc.

NATION-WIDE PROCESSING PLANTS

Albuquerque, N. M., Machine Engineering Service
Chicago, Ill., Metro Electro Processing Corp.
Colorado Springs, Colo., Gagnon Plating & Mfg. Co.
Detroit, Mich., Parker-Wolverine, Div. of the Udylite Corp.
Los Angeles, Calif. Electrofilm Corporation
Minneapolis, Minn., Superior Plating & Rust Proofing Co.
Newark, N. J. Pyrene Manufacturing Company
Ravenna, Ohio Allen Aircraft Products, Inc.
St. Louis, Missouri Mid-West Rust Proof Co., Inc.
Seattle, Wash. Precision Engineering, Inc.
Tulsa, Okla. A & B Commercial Finishing Co.

Electrofilm CORP.
7116 Laurel Canyon Blvd., North Hollywood, Calif.

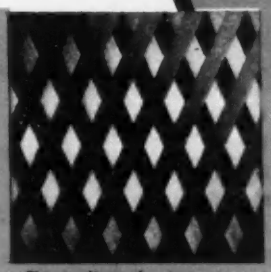
Cuyahoga Makes 'em All!

SPRINGS
WIRE PARTS
WIRE FORMS
STAMPINGS
from
ROUND or FLAT STEEL!

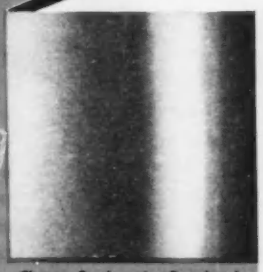
The CUYAHOGA SPRING Co.
SUBSIDIARY OF THE BARIUM STEEL CORP
10234 BEREA ROAD • CLEVELAND 2 OHIO

NICKELOID AT WORK PRE-PLATED METALS

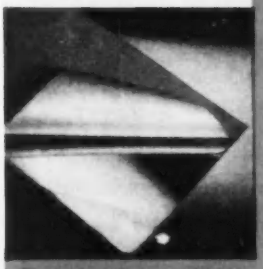
Mirror Back — ¼" stripe Chrome Steel is used. Decorative and durable.



This is diamond stripe pattern, available in any desired base metal.

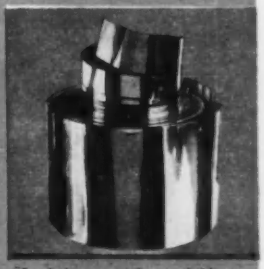


Chrome Steel, satin. Pre-plated. Chrome available in sheets, coils.

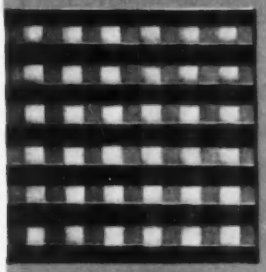


This is Mar-Not, paper adhered, to ease fabrication and handling.

This is Copper plated steel. Lacquer coat recommended.

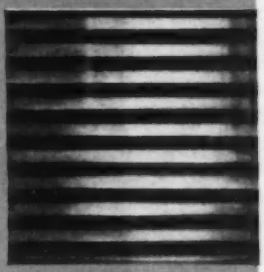


Steel base metals available in coils up to 24" wide.

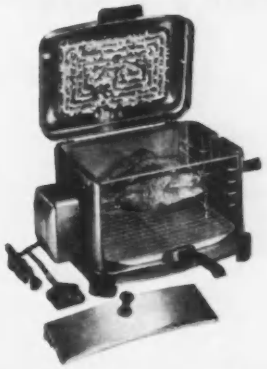


This is square crimp Chrome Zinc. Other crimps also offered.

Pre-plated metal, Chrome bright. May be plated one or two sides.



Horizontal stripe pattern; a striking, modern pre-plated design.



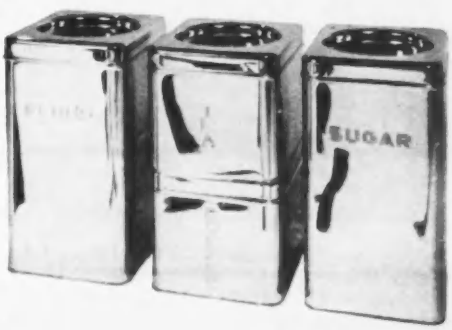
For broiling — a compact, beautiful electric infra-red combination Rotisserie and Broiler. Uses Nickeloid pre-plated Chrome Steel.

For door chimes — ivory plastic cover with satin brass or chrome tubes of pre-plated steel.

In the design and construction of your product, there may be practical possibilities for the adaptation of Nickeloid pre-plated metals. The basic soundness of pre-plating (finishing before fabrication) was never more apparent than today. This 55-year-old idea is being successfully proved on thousands of applications to be seen on the counters and shelves of the American marketplace.

BUILD *QUALITY* INTO YOUR PRODUCT

Kitchen canister set. A popular housewares item, made of Chrome Steel, bright finish.



AMERICAN NICKELOID COMPANY

Established 1898

PERU 4, ILLINOIS

there's a *db in gears

*Decibel (db) tolerances in gears can be important—and if your gear needs call for minimum db tolerances—for *silent* operation—you'll be interested in the unique "extra service" offered by The Cincinnati Gear Company: scientific sound inspection. Each gear you order can be individually *sound-checked* with modern electronic testing equipment for the most exacting noise limits, under a specified load and RPM. No guesswork—the *exact* decibel noise ratio is registered on the dial pictured—your assurance of truly silent gear operation. Inquire today for complete details.

SPUR
WORM
INTERNAL
SPIRAL BEVEL
HELICAL
HERRINGBONE
*CONIFLEX BEVEL
SPLINE SHAFT

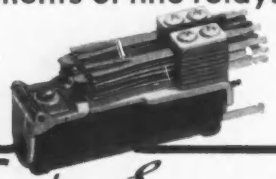
*Reg. U. S. Pat. Off

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. • Cincinnati 27, Ohio

AMF Sterling Relays

JUST OFF THE PRESS!

This catalog of *Sterling* RELAYS will be of help to you in planning your requirements of fine relays



Send for Your copy Today!

Sterling Engineering Company, Inc.
54 MILL STREET - LACONIA, N. H.

Subsidiary of AMERICAN MACHINE & FOUNDRY CO. New York

HOW TO PLAN PRODUCT COLORS

8 pages—20 cents a copy

Howard Ketcham, well-known industrial designer, has developed color and design themes for over 500 products and packaged items ranging from household appliances to locomotives. In this *Product Engineering* report he discusses the principal factors involved in matching color with product function, sales and advertising appeal, maintenance considerations, worker efficiency, safety, and size effect.

Copies of other reports in *Product Engineering's* series of full-color articles covering product improvement through better surface appearance and protection are also available. Write for an editorial reprint order form, listing titles and costs.

READER SERVICE DEPARTMENT

Product Engineering

McGraw-Hill Building,
New York 36, N. Y.

Why Westinghouse specifies DUROID 700 for tap changer support

NO BLISTERED PIECES • HOLDS SHAPE

LITTLE DANGER OF MOISTURE PICK-UP BETWEEN BAKING AND OIL SUBMERSION

MECHANICAL STRENGTH MAINTAINED IN OIL AT 90°C

STAYS FIRMLY FASTENED TO PORCELAIN WITH SELF-TAPPING SCREWS

FORMS INTO THIN-SECTIONED RIBS OF HIGH STRENGTH

NUMBERS CAN BE MARKED TO SHOW THROUGH TRANSFORMER OIL WITHOUT CONTAMINATING IT

You name it— we'll make it— and fabricate it, too.

IN DUROID 700 Westinghouse found a fibrous material that provided a vastly improved support for the tap changer in one of its distribution units. Listed by Underwriters Laboratories, this Duroid is one of many specially processed fibrous materials developed by Rogers. Several steps above conventional fibrous products, it combines rigidity and firmness with non-brittleness. In its ability to outperform standard non-metallic sheet materials in its class, Duroid 700 typifies the special work Rogers is doing with fibrous sheet products. Rogers may have—or can develop—just the material you need to effect a design improvement. We will not only provide the material, but fabricate finished parts as well.

CATALOG Complete data about DUROID 700 and other Rogers Duroids are available. Please write to Dept. E, Rogers Corporation, Manchester, Conn.

Better Parts for Better Products

ROGERS CORPORATION

Established in 1832

DUROIDS for Gaskets, Filters, Electronics . . .	ELECTRICAL INSULATION for Motors, Transformers, Generators . .	PLASTICS Molding Compounds and Laminates	SHOE MATERIALS for Counters, Midsoles, Liners . . .	FABRICATING Producing parts from Rogers materials

WHEN PERKINS GEARS GO IN— TROUBLE GOES OUT!

Specify Perkins custom-made Gears for trouble-free power transmission!

PERKINS MAKES to customers' specifications, in all materials, metallic and non-metallic: bevel gears, ratchets, ground thread worms, spiral gears, helical gears, spur gears with shaved or ground teeth. Have us quote on your requirements.

✱ A new product is the **PERKINS PRECISION SPRING COILER.** This coiler (patent applied for) turns out precision springs—any type, shape, size from wire sizes .005 to .125. Complete data and prices upon request.

✱ Another new product — the **PERKINS "BENDIT 15"**— a patented metal forming machine which bends and shapes sheets, rods; strips tubing into innumerable complex as well as simple forms that would be difficult or even impossible to make by other means. Eliminates need for expensive tools or specialized skills. Height 47", net weight 200 lbs. Write us today for descriptive catalog, prices, etc.

PERKINS MACHINE & GEAR CO.

WEST SPRINGFIELD, MASSACHUSETTS

NEED

?

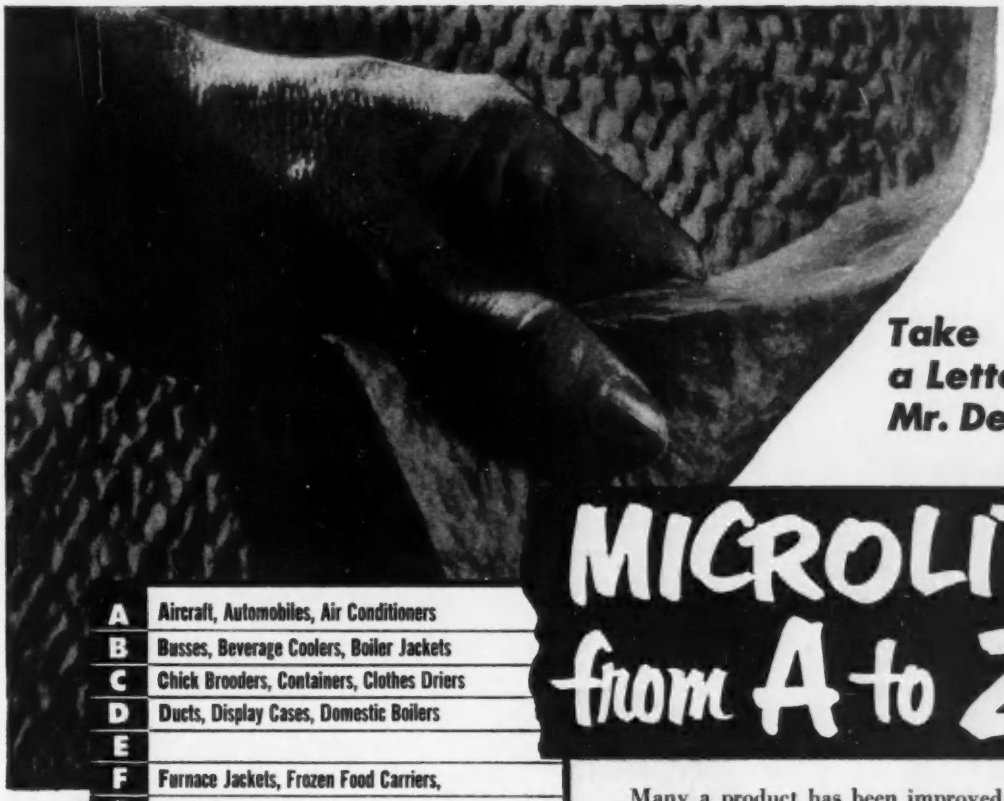
DESIGN ENGINEERS

?

They—and their assistants—are the readers of this magazine. You can hire them by placing a "position vacant" advertisement where they are sure to see it—in our classified section starting on page 451.

Product Engineering

To tap this manpower market, just send in your advertisement before Feb. 16 directly to us at 330 W. 42nd St., N. Y. 36, N. Y.



Take a Letter, Mr. Designer

MICROLITE from A to Z...

A	Aircraft, Automobiles, Air Conditioners
B	Busses, Beverage Coolers, Boiler Jackets
C	Chick Brooders, Containers, Clothes Driers
D	Ducts, Display Cases, Domestic Boilers
E	
F	Furnace Jackets, Frozen Food Carriers,
G	Gaskets
H	Heating Units, Hangars, House Trailers, Home Freezers
I	Ice Buckets, Incubators
J	Jugs (Picnic,) Jet Planes
K	
L	Lighting Fixtures, Life Jackets
M	Metal buildings, Marine Vessels, Milk Trucks
N	
O	Outerwear, Office Machines
P	Pre-Fabricated Buildings, Pillows, Packaging
Q	
R	Railroad Cars, Refrigerators
S	Steamships, Sea Food Boxes
T	Truck Trailers (Refrigerated), Table Pads
U	Upholstery Filler
V	Vacuum Sweepers
W	Warm Air Furnaces, Water Heaters, Winter Clothing
X	
Y	
Z	

Many a product has been improved by Microlite Glass Fiber Insulating Wool. And just as many products are simply waiting for ingenious American designers to give them the benefits of this versatile insulating material. So where do your products fit into the Microlite alphabet? Any ideas?

MICROLITE *Glass Fiber Insulating Wool* is one of the most efficient of all insulating materials. 1-pound density Microlite has a "K" factor of .21 at 75° F. mean. And consider also that

Microlite *insulates effectively against heat transfer*
Microlite *is inorganic, resists fire and moisture*
Microlite *resists settling under vibration*
Microlite *weighs as little as ½ pound per cubic foot*
Microlite *is an excellent absorber of unwanted noise*
Microlite *has a high degree of tensile strength*
Microlite *is soft and pleasant to handle*
Microlite *compresses readily, springs back fully*
Microlite *does the most efficient job in the smallest space*
Microlite *is tough, withstands rough handling*
Microlite *is easily fabricated—cuts with scissors*
Microlite *is shipped in space-saving compressed rolls*
Microlite *is clean and sanitary—fungus-and-bacteria-proof*

For information and samples write Glass Fibers Inc., 1810 Madison Avenue, Toledo, Ohio.

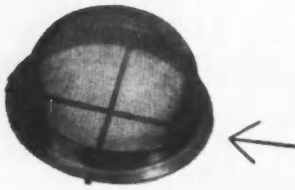
GLASS FIBERS INC.

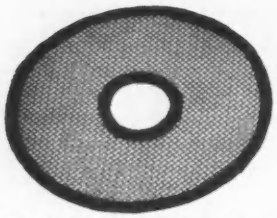
Makers of glass fibers by the ELECTRONIC-EXTRUSION process . . developed, patented and used exclusively by Glass Fibers Inc.

VITRON Yarns • Rovings • Micro-Fibers • Pipe Wraps • Industrial Mat • MICROLITE Thermal-Acoustical Insulation • DURAMAT Vapor Barriers • VIBRAGLASS Machinery Mounting and Packaging Materials • COUSTIC-AIRE and THERMO-JET Aircraft Insulations.

NEWARK
Fabricated Wire Cloth Parts

Wide Range in Sizes and Shapes





Wide Range in Wire Cloth Meshes

We have the facilities and skilled workers to make a great variety of wire cloth parts. We're doing a lot of work along these lines. We do the assembling in our own plant, using our own well known "Newark" Cloth. We bring to this work experience gained by several generations of wire cloth manufacturing and many years experience in fabricating and assembling parts. We'll be glad to quote on your next requirements. If you would like suggestions as to how best make use of wire cloth in the assembling we'll be glad to help. Send us an outline or print of your problem.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

Philadelphia 3, Penna. 1311 Widener Bldg. | San Francisco, Calif. 3100 19th St. | Chicago, Ill. 20 N. Wacker Dr. | New Orleans, La. 520 Maritime Bldg. | Los Angeles, Calif. 1400 So. Alameda St. | Houston, Texas P. O. Box 1970

Position Open

for

Junior Editor

Product Engineering has a position open on its staff for a young engineering graduate with a few years industrial experience in product design or metallurgy. The job is permanent, prospects for advancement are excellent for an engineer seeking an editorial or publishing career. Working facilities and associates are top level.

Some writing experience is preferred. Applicant also must have pleasant personality and develop ability to converse with upper eschelon engineering executives.

Training courses on company time in writing and editing will be part of the job.

McGraw-Hill personnel policies include excellent working conditions, generous vacations, retirement program, group and health insurances, and many other desirable features.

All applications will be answered.

Write, stating salary, to

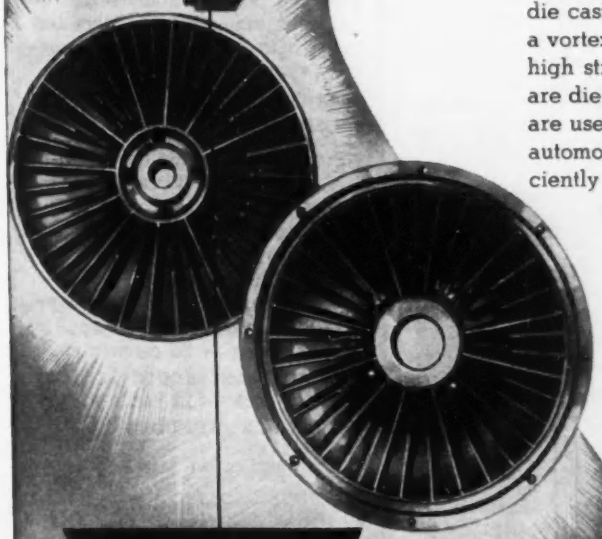
George F. Nordenholt, *Editor*
PRODUCT ENGINEERING
McGraw-Hill Publishing Co.
330 WEST 42ND STREET
NEW YORK 36, N. Y.

"POWER IN A PACKAGE"

GÝROL FLUID DRIVE USES PARKER DIE CASTINGS

to Reduce **COST**, *Add Strength, Minimize Machining*

AMERICAN BLOWER'S Gýrol Fluid Drive Power Unit is another product using Parker Die Castings to achieve greater strength while reducing cost. The two rotating elements with die cast blades shown at the left transmit the power through a vortex of oil. Alloy aluminum is used for light weight and high strength. Machining is minimized because the blades are die cast accurately and cleanly. Gýrol Fluid Drive units are used profitably in giant utilities, steel mills, paper plants, automotive and many processing plants. These units efficiently power many industrial machines—conveyors, centrifugals, cranes, mixers, winders, spinners and others where smooth acceleration, overload protection and shock absorption are desirable. These die castings by Parker, adding strength, cutting weight and minimizing machining costs, are vital elements in the top performance of Gýrol Fluid Drive units. Call Parker on your next die casting requirements. Our engineers will work with you to our mutual benefit.



and when you think of Die Castings THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Penna.

PARKER ALUMINUM *and* ZINC *Die Castings*

New RESISTOFLEX hose assembly . . .

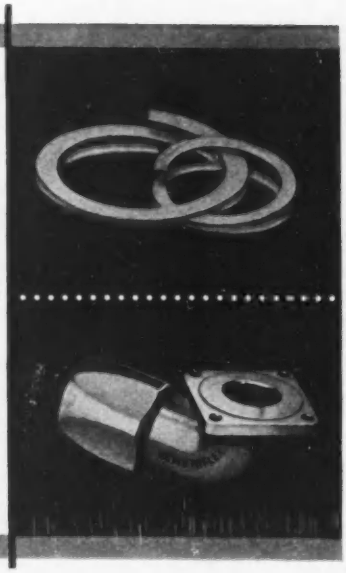
withstands medium-high pressures without wire reinforcement

I.D. (inches)	Working Pressure (psi)	Min. Burst Pressure (psi)	Assembly Tensile Strength (lbs.)
¼	2300	9200	900
⅜	2050	8200	2500
½	1800	7200	3500

Synthetic fibre-braid carcass and non-aging compar tube in Resistoflex hose provide strength for medium-high pressure hydraulic systems without need for metal reinforcements. This assures flexibility with extreme resistance to fatigue. These hose assemblies have high pull strength and long hydraulic impulse life. The compar tube also assures freedom from swelling and gumming due to hydraulic oils, and full flow through fittings.

TEFLON® SPIRAL BACK-UP RINGS
Made from uniform "Fluoroflex-T" tubing – stress relieved before machining for dimensional stability of rings. These anti-extrusion rings withstand −100°F to +500°F. Self lubricating, they eliminate abrasion on "O" rings, reduce friction of the assembly. Chemically inert and non-fraying, they cause no malfunctioning of other hydraulic system components.

AIRCRAFT HOSE ASSEMBLIES
"AN" types which conform in every particular to military specifications. All sizes, for hydraulic, pneumatic and vacuum lines, as well as fuel, gas and oil lines. Assemblies with Resistoflex forged aluminum, compact, flanged, elbow fittings carry USAF and BuAER approvals. Send for AIRCRAFT CATALOG with full specification details.



RESISTOFLEX

CORPORATION

Belleville 9, New Jersey

* *Resistoflex trade mark for products from fluorocarbon resins.*

When and How to Use PORCELAIN ENAMEL COATINGS

8 pages — 20 cents a copy

In line with the rising use of porcelain enamel coatings for a steadily increasing variety of products, there are now hundreds of formulations available for many different property requirements . . . in practically any color you may want.

This Special Editorial Report contains invaluable information on types of porcelain enamel coatings, application methods, properties, and base-metal design factors. It is one of *Product Engineering's* brilliant series of full-color reports on product improvement through better surface appearance and protection.

Copies of other reports in this series are also available.

WHICH COATING FOR GRAY IRON?
8 pages — 25 cents a copy

IDENTIFYING YOUR PRODUCT
8 pages — 25 cents a copy

ELECTROLYTIC AND CHEMICAL COATINGS
8 pages — 25 cents a copy

TEXTURED ORGANIC COATINGS
8 pages — 25 cents a copy

HOW TO PLAN PRODUCT COLORS
8 pages — 20 cents a copy

FINISHES FOR ALUMINUM PRODUCTS
8 pages 20 cents a copy

SELECTING ORGANIC COATINGS FOR METAL PRODUCTS
8 pages — 15 cents a copy

PHOSPHATE COATINGS FOR MILITARY PRODUCTS
8 pages — 25 cents a copy

WRITE TO READER SERVICE DEPARTMENT:

Product Engineering

McGraw-Hill Building, New York 36, N. Y.

Survey by Leading Motor Manufacturer Proves

NORMA-HOFFMANN *Prelubricated* "CARTRIDGE" BEARINGS

Slash Motor UPKEEP COSTS

A recent survey of over 131,626 A-C motors shows the use of "Cartridge" Prelubricated bearings saved a yearly average cost of $270.00 per hundred motors by eliminating periodic relubrication.

In addition to this $270.00 saving, motors using "Cartridge" bearings showed an indicated saving of $480.00 by reducing motor outage, lost machine time and man-hours.

A total yearly saving of $750.00 per hundred motors! You, as a manufacturer of motors, machine tools, pumps or other machinery can pass these savings to your customers by using Norma-Hoffmann "Cartridge" Ball Bearings. How — because these patented bearings require no periodic relubrication.

Made to double-row width, Norma-Hoffmann "Cartridge" single-row ball bearings have 100% more grease capacity than conventional width sealed bearings. The highly efficient seals keep dirt out, grease in. Factory-packed with Norma-Hoffmann's specially compounded "stability-tested" grease . . . grease that is highly resistant to oxidation and breakdown . . . assures dependable operation for long periods without regreasing.

Use Norma-Hoffmann "Cartridge" Ball Bearings in your products. Our engineers are always available for consultation on your bearing applications. Write for their services.

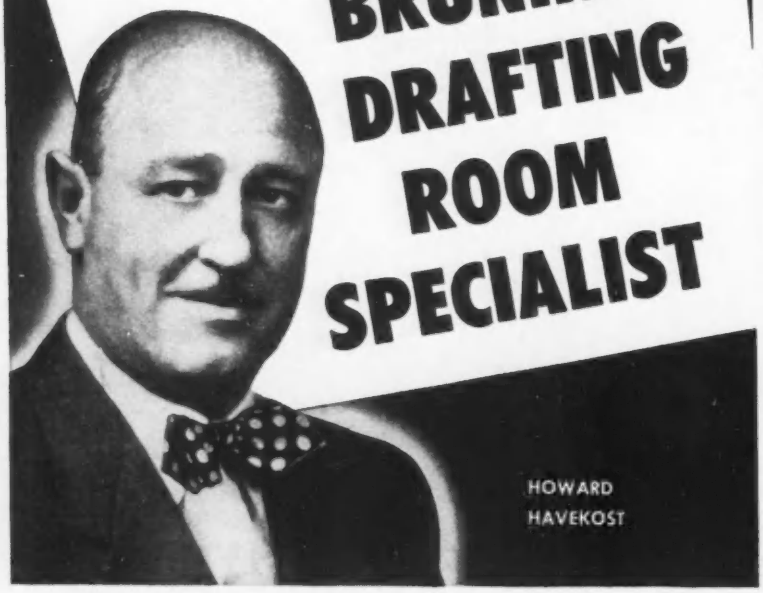
NORMA-HOFFMANN *Precision* BEARINGS

BALL • ROLLER • THRUST

NORMA-HOFFMANN BEARINGS CORPORATION • STAMFORD, CONN.
FIELD OFFICES: Atlanta, Birmingham, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Jacksonville, Kansas City, Los Angeles, San Francisco, Seattle

We'd like to introduce your

BRUNING DRAFTING ROOM SPECIALIST



MR. HOWARD HAVEKOST SAYS:

"For 23 years, I've been working very closely with hundreds of drafting rooms in the territory I serve. My customers have come to depend upon Bruning for practically all of their drafting room needs, and they appreciate being able to get direct-company service and personalized attention."

Mr. Havekost is typical of Bruning's many specialists. These trained men take expert care of all the drafting room requirements for architects, designers, engineers and draftsmen from coast to coast, working from one complete and responsible source of supply.

Wherever you are, consult your Bruning Drafting Room Specialist about your needs. He'll help you save time and money, and see to it that you get top-quality materials.

BE SURE TO ASK HIM ABOUT COPYFLEX, the whiteprinter that needs no exhaust ducts, gives you dry, ready-to-use prints in seconds.

From Pencil to Print, Only BRUNING HAS EVERYTHING

- COPYFLEX Whiteprinters
- Drafting Machines
- Tracing Papers and Cloths
- Surveying Equipment
- Drafting Furniture
- Drawing Instruments
- Sensitized Papers, Cloths, Films
- Electric Erasers
- Complete line of Supplies and Equipment

MODEL 93 COPYFLEX Finest large volume whiteprinter on the market. Makes ready-to-use prints up to 42" in width by any length. Needs no installation, exhausts or plumbing.

BRUNING
Everything for the Engineer and Draftsman

B-3-1

—CHARLES BRUNING COMPANY, INC.—
Dept. 23 Teterboro, N. J.

- ☐ Please have a Drafting Room Specialist call.
- ☐ Send me free booklets on COPYFLEX.
- ☐ Show me COPYFLEX in action (no obligation).

Name.....Title.....
Company.....
Street.....
City.....Zone.....State.....

—OFFICES IN PRINCIPAL CITIES—

There's a girl in our office . . .

. . . Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins" to the manufacturers concerned.

The job keeps her busy, too. She handles several thousand requests from **Product Engineering** readers every month. And she's anxious to be of service to you whenever she can.

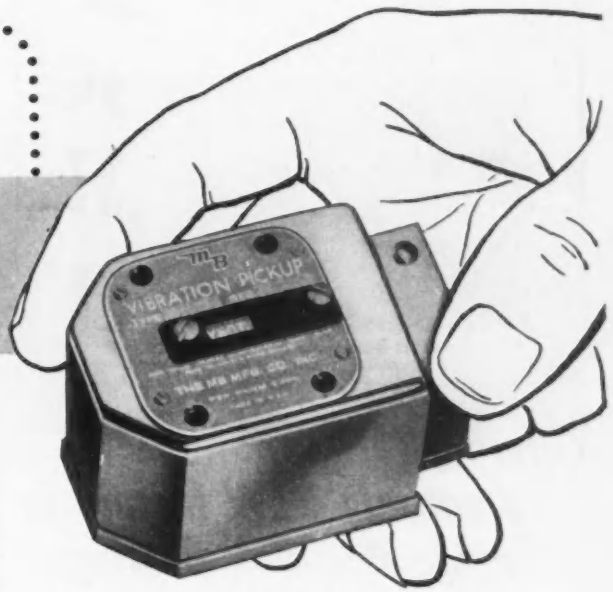
So check the "New Catalogs and Bulletins" insert if you haven't already done so. You'll find a lot of useful information listed there . . . and any of it is available to you promptly and without cost.

Product Engineering

Vibration Engineering that solves your problems

PROBLEM: To locate vibration and measure it

SOLUTION: This sensitive, velocity-type MB Vibration Pickup



Illustrated here is the MB Type 122 Vibration Pickup developed for jet engine testing. It withstands 500° F.

TO LICK VIBRATION you've got to *locate* it first. That's a job for which the MB Vibration Pickup was developed. It has the sensitivity needed to detect the faintest vibration—the stamina to withstand the strongest.

When fastened to the product, component or structure under test, this pickup faithfully converts vibratory motion into elecrical output. Its signal can be seen and studied on the oscilloscope; or measured by meter such as the direct-reading MB Vibration Meter; or fed to vibration analyzer.

The pickup is usable from 5 to 2000 cps in horizontal or vertical operation. Magnetic damping assures calibration stability. Lightweight moving coil and low-friction pivoting account for the pickup's wide range of serviceability.

Today, this unusual instrument is being found indispensable for accurate vibration detection. It's one more reason why MB is known as headquarters for the answers to vibration problems—including those in shake testing, measurements, vibration isolation and shock mounting. Full details on pickups in Bulletin No. 124-6. Write us.

Double duty vibration exciter

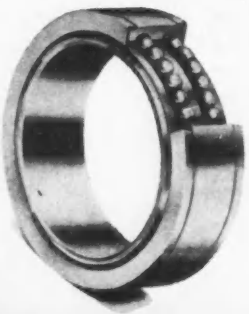
Specification MIL-E-5272 and other vibration testing specifications can be met with the Model C-1 Shaker. It develops 50 pounds of force. An electromagnetic shaker, it features easy, continuous control of force and frequency. It also serves as a calibrator for vibration pickups.

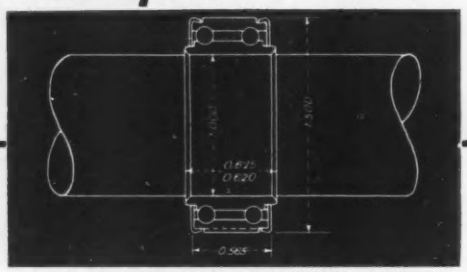
The technique of calibration has been thoroughly presented in MB's booklet entitled "The Calibration of Vibration Pickups to 2000 cps." Send for Booklet C-11-6.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT

NEW . . . . . .
COMPACT . . . .
PRACTICAL . . . .
PRELUBRICATED
•
BALL BEARING
BUSHINGS
for
limited space





Drawing shows Double Row Split Ball Bearing Bushing having a section height of only 0.250". A unique method of loading a full complement of balls does away with the need for a retainer.

Offering an entirely NEW feature in Double Row Ball Bearings

Here for the first time a ball bearing bushing is available which meets the needs of such applications as:

sheaves *idlers*
fulcrums *cams*
oscillating motions, etc.

where space limitations have heretofore made it impossible to apply double row ball bearings. Every engineer knows this:—every type of bearing whether bronze bushings . . . needle rollers . . . balls . . . or rollers . . . depends on lubrication. These ball bearing bushings, pre-lubricated at the factory with provision for re-lubrication, will give hundreds of hours of service without either attention by the operator or, more important, creating wear on vital and often critical parts.

All these advantages apply to a bearing which, having a greater number of balls, gives it greater capacity than ever before possible under limited space conditions.

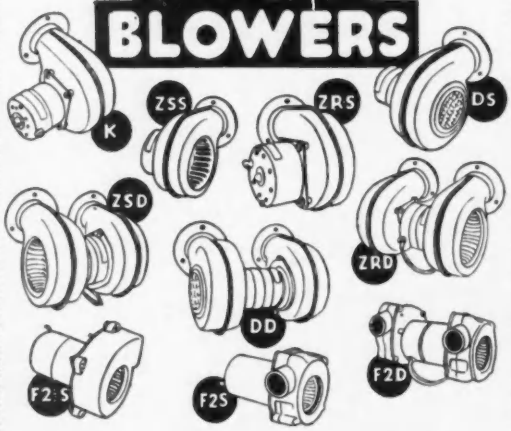
These new bearings are available with bore tolerances: for press fit on selected shafting for shaft rotation; and loose fit for use on cold rolled shafting for outer race rotation.

Investigate the possibilities of these new bearings by sending at once for illustrated literature, sizes and capacities.

SPLIT BALLBEARING CORPORATION

LEBANON
NEW HAMPSHIRE

HEINZE BLOWERS



For large photo darkrooms, laboratories, refrigeration units, air conditioning equipment, furnace draft boosters and similar equipment.

For cooling electronic tubes in transmitters, induction heaters and diathermy equipment.

For advertising displays and many other uses.

Battery-operated for cars, trucks, boats and other portable installations.

VARIOUS MOUNTING DEVICES

The Heinze catalog describes all types in detail.

Heinze Electric Co.
685 Lawrence Street
LOWELL, MASS

MATCH

the quality of your product with

Grammes

METAL NAME PLATES

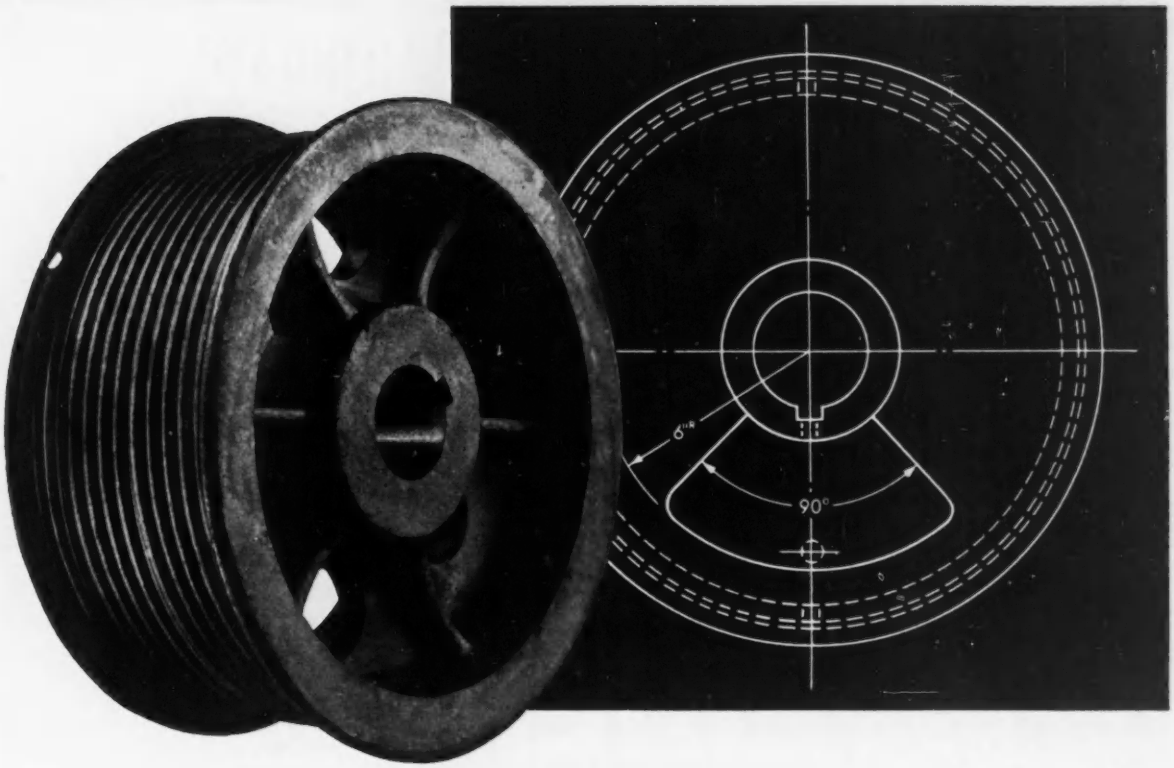
Grammes metal craftsmen will make your name plate stand out and make it "sell" as well as *tell*. They are experienced in giving you just what you want: Readability that endures in metal. A sketch or blueprint—or just a hint—is all we need to show you what we can do with a name plate for you. Send for our "Tips on Name Plate Selection and Design". Write to:

NAME PLATES
DIALS

L. F. GRAMMES & SONS
INCORPORATED
ALLENTOWN, PA.

TRIMS • BEZELS
PANELS

SPECIALISTS IN DECORATIVE METAL



Costly to fabricate ECONOMICAL TO CAST IN GRAY IRON!

GRAY IRON Characteristics Include:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Durability
- Vibration Absorption
- Machinability
- Wide Strength Range

The cable drum, shown above, was formerly produced by using plates of various thickness—cutting, assembling, welding and finally machining. Valuable and costly man-hours were expended in co-ordinating the efforts of the several mechanics involved in these operations. Thus, supervisory costs were added to high fabrication costs.

By redesigning the part as a Gray Iron casting, a cost saving of 41% per unit was effected. On a typical order involving 20 castings, the net saving to the customer was $197, *after* initial pattern cost had been written off. Note that grooves are *cast in* instead of machined, effecting a substantial saving in machining time.

In addition to these savings, much longer operating life can be expected, because of Gray Iron's superior resistance to metal-to-metal wear and galling.

Don't miss opportunities like this to save man-hours, cut costs, and increase operating life by *redesigning in Gray Iron!* Write for technical information on advantages of the Gray Iron casting process.

Make it Better with Gray Iron • **Second largest industry in the Metal-working field**

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

FILLING AN ORDER BY AUTOMATIC SPINNING. Automatic machines, developed by Teiner, permit precision spinning to reduce costs on long-run items. Example of the all-gauge — all-metal — any-quantity — spinning capacity available at Teiner. ***Write for color Brochure 52P.***

ROLAND TEINER CO. INC. METAL SPINNING

ROLAND TEINER

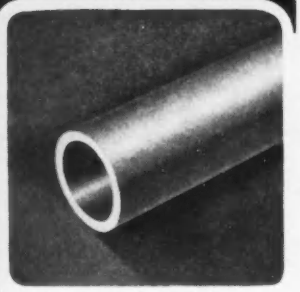
COMPANY, INCORPORATED

134 TREMONT ST., EVERETT 49, MASS. Tel. EV 7-7800

PROPER APPLICATIONS . . . *Product Improvement*

with CUSTOM EXTRUSIONS by H and R INDUSTRIES

Adjustment strip for a welding helmet headband produced for Fibre Metal Products Co. of Chester, Pa.



Corrosion resistant piping made to order for the Atlas Mineral Products Company of Mertztown, Pa.

Because of the properties required in the custom extruded products shown above, H & R used Kralastic, a modified styrene-butadiene, high in corrosion resistance and impact strength.

H & R offers a complete custom extrusion service capable of turning out the right plastic material in the exact form you need, at a price you'll appreciate. We are fully equipped to make all necessary dies for sheets, strips, rods, tubes and shapes.

Send us your problem—we'll be glad to send samples, recommendations and quote prices. Absolutely no obligation on your part.

H & R INDUSTRIES Extruded Plastics

NAZARETH, PENNA.

DID YOU FORGET

TO TELL US THAT YOU'RE

MOVING

?

Planning to move? If you are, then won't you please let us know as far in advance as possible? It takes time to make address corrections on your Product Engineering subscription stencil. By notifying us about your change in address, you make sure Product Engineering reaches you. There's a handy coupon below to report the change to us. Do it now so you continue receiving your Product Engineering without a single hitch in service. Thanks for cooperating!

Product Engineering

Circulation Department

330 West 42nd Street, New York 36, N. Y.

CHANGE OF ADDRESS NOTICE

On or about..... my new address will be:

Street .....

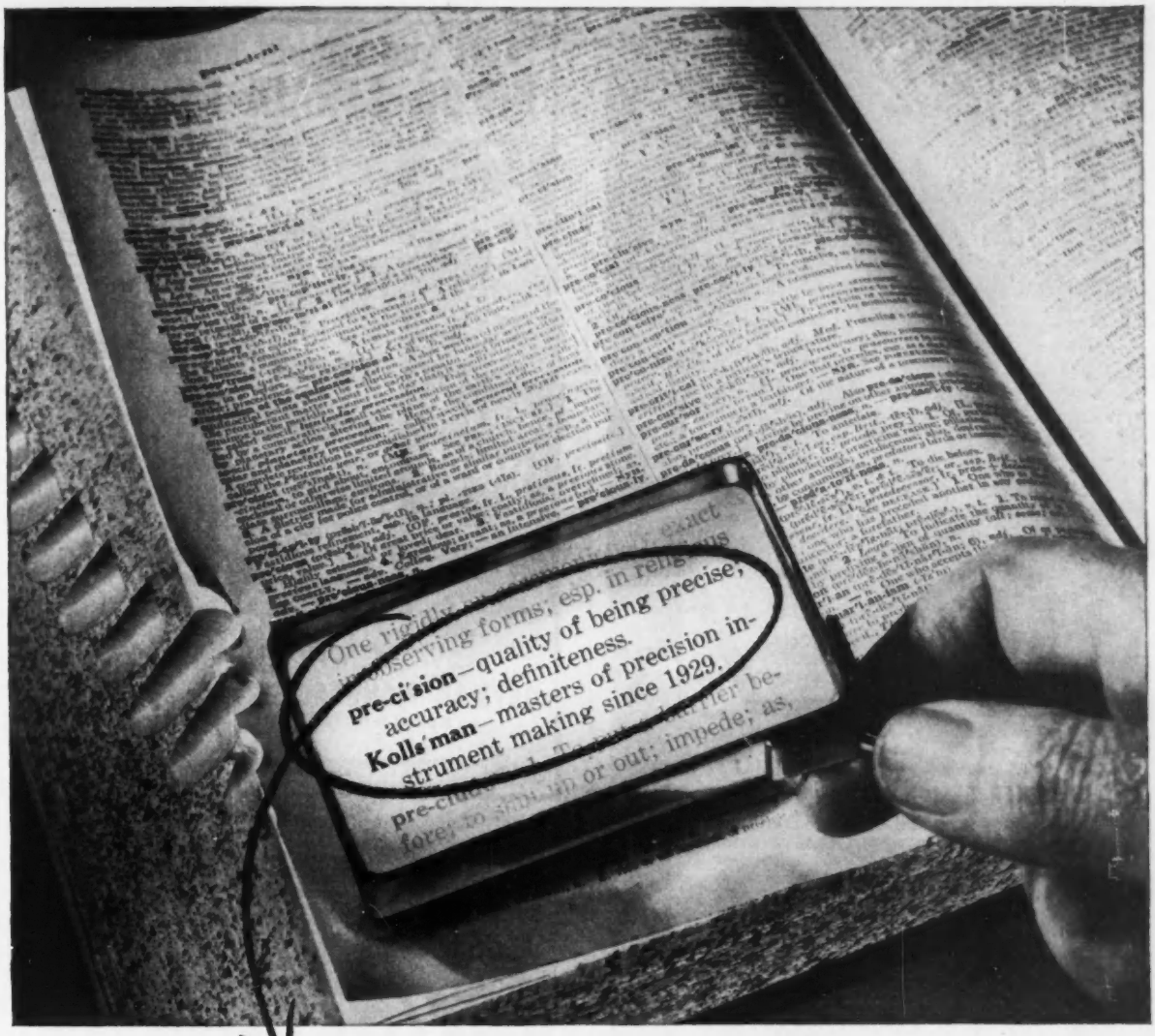
City.....Postal Zone #...State .....

Signed .....

My old address is:

Street .....

City..... Postal Zone #...State...


pre-ci'sion—quality of being precise; accuracy; definiteness.
Kolls'man—masters of precision instrument making since 1929.

Synonyms

THE KOLLSMAN INSTRUMENT CORPORATION—designers, developers and manufacturers of precise, dependable instruments in the fields of:

Aircraft Instruments and Controls • • Miniature AC Motors for Indicating and Remote Control Applications • • Optical Parts and Optical Devices • • Radio Communications and Navigation Equipment

While current facilities of our laboratories and plants are geared to production for National Defense, the planning divisions of Kollsman are ever active. And versatile Kollsman research engineers stand ready to assist America's scientists in the solution of instrumentation and control problems.

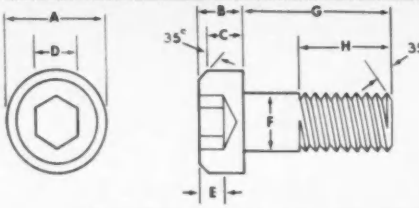
KOLLSMAN INSTRUMENT CORPORATION

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

SUBSIDIARY OF

Standard COIL PRODUCTS CO. INC.

Mac-it®
DESIGN ENGINEERING at YOUR Service..



MAC-IT PARTS COMPANY							
MATERIAL SAE 4140 STEEL ALLOY - ROCKWELL							
FINISH CHROMIUM PLATING ON STEEL G.M. 4251-							
TOLERANCE IN LENGTH THE TOLERANCE IN LENGTH							
A	B	C	D	E	F	G	H
1/8	244	229	185	127	248	5/8	3/8

FASTENER DESIGN

Mac-it socket-head screws, providing strength without bulk, give lighter weight, streamlining, and more secure fastening to equipment you design. Whether the design problem involves standard or special screws, Mac-it will add to the appearance, efficiency and performance of the equipment. Use Mac-it Fastener Engineering Service for all problems involving screws for any type application.

MAC-IT PRECISION

The precision manufacture and quality control used in making Mac-it Screws provide users with high dimensional accuracy and uniformity. All Mac-it Screws in both coarse and fine threads are held to a class-3 fit. Mac-it maintains a Fastener Engineering Service for the design, development and production of screws for all types of applications.

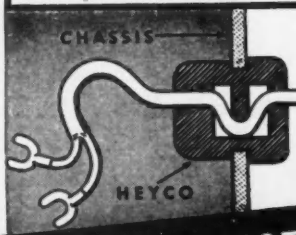
DISTRIBUTOR SERVICE

Hundreds of Mac-it distributors from coast to coast are ready to render immediate service in supplying your requirements for standard or special screw products.

MAC-IT SCREW DEPARTMENT
STRONG, CARLISLE & HAMMOND COMPANY
1392 W. 3RD. STREET • CLEVELAND 13, OHIO
Manufactured by Mac-it Parts Co., Lancaster, Pa.

Contact your nearest Mac-it distributor or the Home Office, Cleveland, Ohio, for the Mac-it Catalog No. 49 which contains full technical data.

Facts you should know about HEYCO STRAIN RELIEFS!
the Nylon Bushings that Anchor cord to housing



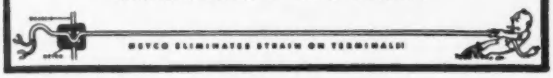
1. Absorb cord pull, push and torque
2. Insulate wire from housing

CUT PRODUCTION COSTS
IMPROVE PRODUCT QUALITY

APPROVED SA UL

SAMPLES? Send wire size and chassis information—
Try HEYCOS at no cost to you—today!
MADE IN ALL SIZES FOR CLOCK WIRE TO S-10/3 CABLE

HEYMAN MANUFACTURING COMPANY
KENILWORTH 3 NEW JERSEY



COPPER • MONEL • K. MONEL • BRONZE • CHROME ALLOY • STAINLESS STEEL • DRILLED BALLS • ALUMINUM • PLASTICS • GLASS

Hartford
PRECISION
BALLS

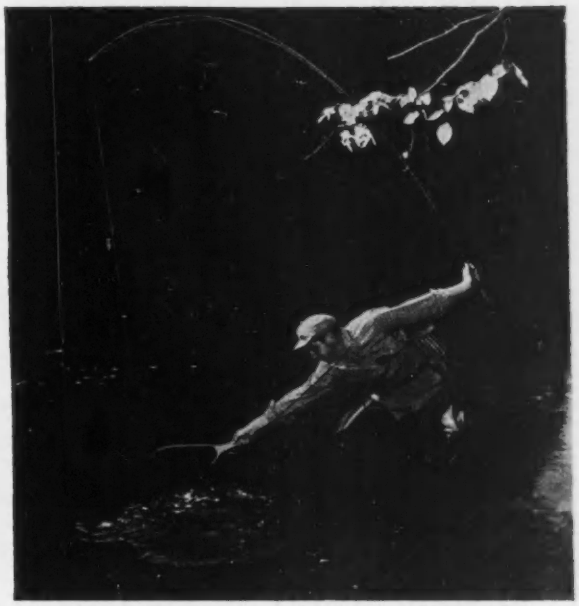
Precision balls made for your job. In many materials. Send your specifications to our Engineering Department. Their recommendations will be forwarded to you promptly.

THE HARTFORD STEEL BALL CO.
HARTFORD 6, CONN.

DETROIT — CHICAGO — NEWARK, N. J. — LOS ANGELES, CAL. — EXPORT

How would YOU solve these 2 problems?

1. IN SOFTBALL MANUFACTURE the most troublesome problem was to obtain absolute uniformity in the kapok cores. These determined hardness, density and shape of the finished balls. H. Harwood & Sons, Inc., of Natick, Mass. solved this problem by molding the cores under hydraulic pressure at closely controlled high temperature. Two inexpensive THERMOSWITCH units per mold provide the needed temperature control at low cost.



2. TAKING THE STRETCH and shrink out of Nylon fish line posed a big problem. It can only be done under high heat. One manufacturer was quoted $18,000 for complicated control equipment. Instead — and very successfully — he stretches the line in a heated die, temperature-controlled by a Fenwal THERMOSWITCH. Cost, less than $25!

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature control problems and improving production throughout all industry.

4. SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write **Fenwal Incorporated, 22 Pleasant Street, Ashland, Massachusetts.**

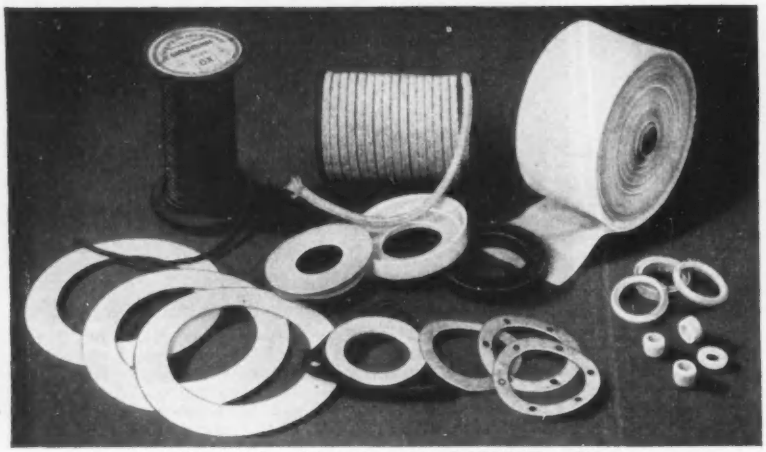
Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE . . . *but only to heat*

When it comes to Teflon* PACKINGS and GASKETS come to Garlock...manufacturers of mechanical packings since 1887



Above—A few of the wide variety of TEFLON packings and gaskets manufactured in the Garlock factories.

GARLOCK pioneered in the design and manufacture of packings and gaskets made of TEFLON. Garlock products made of TEFLON are unaffected by acids, organic solvents and other chemicals at operating temperatures from below −90°F. up to 500°F. These packings and gaskets are ideally suited for many other applications due to TEFLON's low coefficient of friction.

We have the facilities to mold, machine, or form TEFLON in a wide variety of shapes and sizes for packing and gasketing. When you need finished TEFLON parts contact your Garlock representative or write for our TEFLON Catalog.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

*The DuPont Company's Trademark

GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

SELECTING ORGANIC COATINGS FOR METAL PRODUCTS

8 pages—15 cents a copy

•

This Special Editorial Report is the latest in the series of full-color articles covering product improvement through better surface appearance and protection. It covers the latest data on the types of finishes . . . the advantages and disadvantages of natural and synthetic bases . . . the basis of finish selection . . . and long range trends in organic coatings.

Copies of earlier reports in this series are also available.

FINISHES FOR ALUMINUM PRODUCTS
8 pages—20 cents a copy

HOW TO PLAN PRODUCT COLORS
8 pages—20 cents a copy

PORCELAIN ENAMEL COATINGS
8 pages—20 cents a copy

TEXTURED ORGANIC COATINGS
8 pages—25 cents a copy

ELECTROLYTIC AND CHEMICAL COATINGS
8 pages—25 cents a copy

IDENTIFYING YOUR PRODUCT
8 pages—25 cents a copy

WHICH COATING FOR GRAY IRON
8 pages—25 cents a copy

READER SERVICE DEPARTMENT

Product Engineering

McGraw-Hill Building
New York 36, N. Y.

for a few pounds of copper... or a truckload... Call Chase

Need just a few lengths of seamless brass tube? We'll be glad to hand them to you "over the counter." Or if your job calls for large quantities of brass or copper sheet, rod, wire or tube, we can speed it on its way to you. That's the kind of service you can get by calling your nearest Chase warehouse.

We can supply you, subject to government controls, with hundreds of items for production, maintenance or repair. That's why it pays to "try Chase first" for anything in brass or copper.

Chase BRASS & COPPER

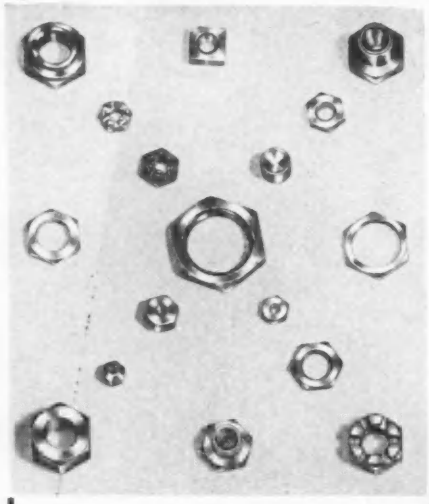
WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	(†sales
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)

UNIFORMITY • DEPENDABILITY • SERVICE • ECONOMY
in SPECIAL FASTENERS

Get all 4 with WESTFIELD METAL PRODUCTS



★ **MATERIALS** — Steel, brass, stainless steel, bronze and aluminum.

★ **CAPACITY** — From 3/16" hexagon to and including 1 1/16" hexagon across flats, from 1/16" thick to and including ¾" thick.

★ **THREAD SIZES** — From #2 up to and including ⅞" diameters, any pitches desired.

SEMI-FINISHED MILLED-FROM-THE-BAR STANDARD AND SPECIAL NUTS
HEXAGON OR SPECIAL SQUARE NUTS
SCREW MACHINE PRODUCTS
PLATING AND HEAT TREATING

Write to Dept. B for NEW— Illustrative Folder

WESTFIELD METAL PRODUCTS CO., INC.
WESTFIELD, MASS.

FREE...

BULLETIN 161

2 BULLETINS on SHORT RUN STAMPINGS

BULLETIN 101

FOR... DESIGNERS
METHODS ENGINEERS
PROCESS ENGINEERS
PRODUCT ENGINEERS
MECHANICAL ENGINEERS
RESEARCH ENGINEERS
SUPERINTENDENTS
PURCHASING AGENTS

SEND FOR THESE HELPFUL BULLETINS TODAY

SERVICES BULLETIN NO. 161 describes the facilities that make Federal a *one-stop* stamping service. Specifications cover special die stamped wrenches, nameplates, and quality short run stampings from any stampable material.

COSTS BULLETIN NO. 101 shows how Federal's special dies give the accuracy, exact duplication, and tolerances of permanent dies *plus* saving as much as 80% on die costs.

Federal TOOL AND MANUFACTURING CO.
3620 ALABAMA AVE. (ST. LOUIS PARK)
MINNEAPOLIS, MINNESOTA
"QUALITY STAMPINGS IN SMALL QUANTITIES"

How to Benefit From Double-Purpose

TEXTURED ORGANIC COATINGS

8 pages—25 cents a copy

Textured organic coatings serve the double purpose of protecting metals and furnishing finishes of unusual eye-appeal. These coatings are extremely useful as they obscure marks left on metallic surfaces by production and finishing operations effectively with one coat.

All the latest information on these "special effect" coatings is available to you in this report. Included is an invaluable chart showing suggested uses, application methods, properties, and color possibilities.

Copies of other reports in this series on improved product appearance and protection are also available.

WHICH COATING FOR GRAY IRON?
8 pages—25 cents a copy

IDENTIFYING YOUR PRODUCT
8 pages—25 cents a copy

ELECTROLYTIC AND CHEMICAL COATINGS
8 pages—25 cents a copy

TEXTURED ORGANIC COATINGS
8 pages—25 cents a copy

HOW TO PLAN PRODUCT COLORS
8 pages—25 cents a copy

FINISHES FOR ALUMINUM PRODUCTS
8 pages—20 cents a copy

SELECTING ORGANIC COATINGS FOR METAL PRODUCTS
8 pages—15 cents a copy

PHOSPHATE COATINGS FOR MILITARY PRODUCTS
8 pages—25 cents a copy

WRITE TO READER SERVICE DEPARTMENT:

Product Engineering
McGraw-Hill Building
New York 36, N. Y.

Reserve your copy of this NEW CATALOG—NOW!

You'll find a wealth of valuable information in this new catalog. It gives you complete, up-to-date facts on all the more than 7000 Honeywell industrial controls for regulating temperatures, pressures, humidity, vacuum and liquid level.

To make sure you'll get your copy promptly, just fill out and mail the coupon below.

And—whenever you run into an industrial control problem, call on your nearest Honeywell representative for cooperative engineering assistance. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4459 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
First in Controls

MINNEAPOLIS-HONEYWELL REGULATOR CO.
Industrial Division, 4459 Wayne Ave., Philadelphia 44, Pa.

Gentlemen:
Please put my name on your list to receive new Catalog No. 8305, "Honeywell Industrial Controls."

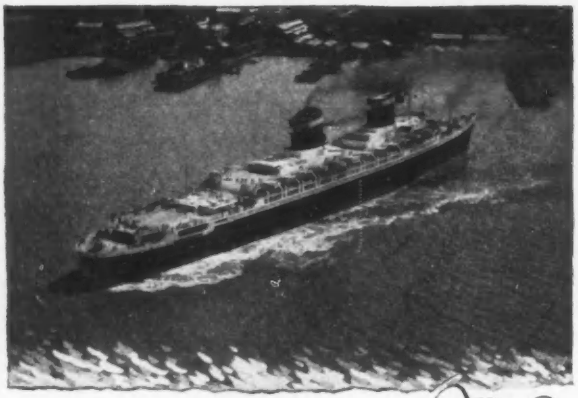
Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____



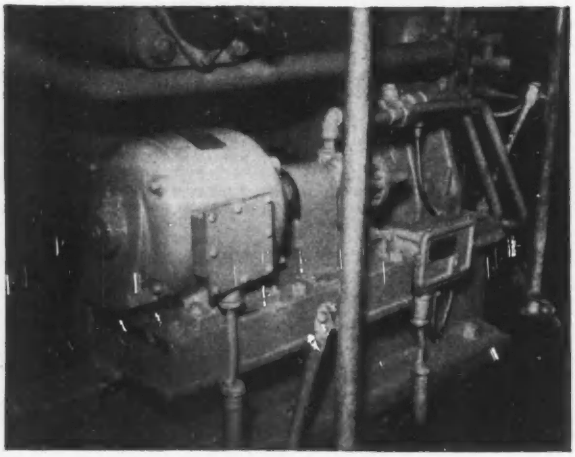
A POTATO never had it so good!

Even the supplies ride first class on the S.S. United States. Many of the motors powering York air conditioning equipment are Wesche designed and built. They are Marine type Class C drip proof motors ranging from 1/15 to 2½ H.P.

On many lesser vessels passengers' quarters, and maybe even the champagne room gets air conditioning. But in this ship the order for one Wesche motor was for "the potato room." The first time you ride the United States "live it up," friend, you're eating Idaho-York-Wesche air conditioned potatoes.

Send for the Wesche catalog of torque and special motors of all types and sizes.

THE B. A. WESCHE ELECTRIC CO. (Welco)
1624 VINE STREET • CINCINNATI 10, OHIO



FUNK *Special* POWER UNIT CLUTCHES *and* TAKE-OFFS

This right angle drive and heavy-duty clutch unit is only one of many engineered and manufactured by FUNK. There are types and styles to fit almost any requirement for shaft speed and installation space. They are designed to fit any standard SAE flywheel housing or Ford Industrial Engine. Our engineers will be glad to work with you on any special power problem.

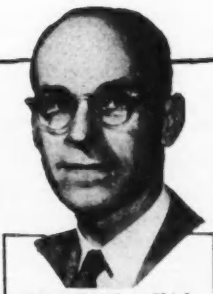
FUNK Products include:

Straight Power Take-Off Clutches
Gear Reduction Take-Offs
Right-Angle Take-Offs
Front End Take-Offs
Jack Shaft Extensions
Ford Tractor Conversion Kit, changes to 6 or V-8 engines, doubles the power at 1/3 the cost.

FUNK AIRCRAFT CO.
3301 Airport Drive Coffeyville, Kansas

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD



Robert D. Gilson, Chief of Structures. Has worked on many top aviation projects in the aircraft industry, specializing in structural problems.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD *Aircraft Division*
HAGERSTOWN, MARYLAND

Precision casting news

by Arwood Engineers

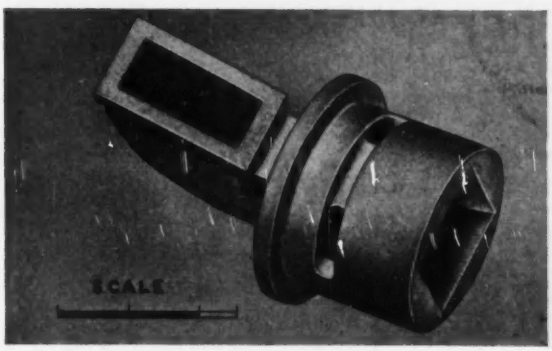
Each month Arwood illustrates an unusual casting. This month it is a magnesium elbow produced for radar equipment.

The first point is that because of design and shape this casting is practically impossible to produce by any method except precision casting.

Important, too, are these facts. The internal waveguide dimensions are held to a maximum tolerance of ± .003 with no further finishing required. With a maximum wall thickness of .050 the part must withstand a pressure test of 35# p.s.i. and pass X-ray requirements.

But magnesium is only one metal that Arwood casts. Others are aluminum, copper, bronze, brass and various steels. Details are in our booklet, "Alloy Selection and Design for Investment Castings."

TIP TO DESIGN ENGINEERS—When a Product Design Engineer works closely with our engineers the impossible often becomes possible. Through the ingenuity of our engineers and tool designers, the part shown was produced as a complete unit and seven parting lines were eliminated.



from Arwood

Wright Bronson, Junior and Senior

Both Wright Bronson, Senior and Junior, are doing outstanding sales engineering work for Arwood. They consider engineering service the greatest single factor in their successful Arwood operation. Because both are graduate engineers from Cornell they are able to give sound and valuable advice to their many friends in Ohio.

Wright Bronson, Jr., joined Arwood in 1948 and soon made himself felt in the organization. In 1951 his father brought his valuable experience to Arwood to make it a team, something they had been looking forward to for years.

For more complete information write for our booklet, "Alloy Selection and Design for Investment Castings."

☆ ☆ ☆

An important new book—"Investment Casting for Engineers"—has just been published by Rheinhold Publishing Co., New York. It is highly recommended reading for all design engineers.

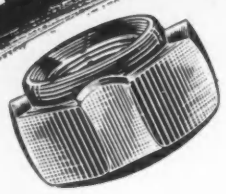
ARWOOD

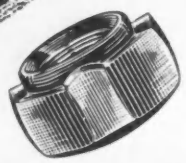
PRECISION CASTING CORP.

68 WASHINGTON STREET • BROOKLYN 1, N. Y.

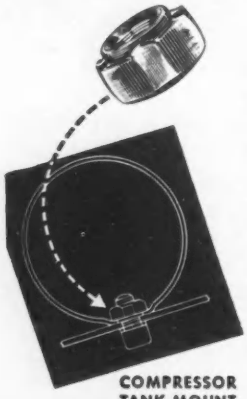
Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

The ANSWER to "Blind Spot" Problems in Assembly of Metal Parts





MIDLAND WELDING NUTS



COMPRESSOR TANK MOUNT

ENGINE MOUNT

● Welded to inside spots, where it is difficult or impossible for hands or tools to reach, MIDLAND WELDING NUTS hold fast while bolts are turned into them.

This method speeds up the assembly of metal stampings, and helps spread the use of manpower. Midland Welding Nuts enable one man to do the work formerly requiring two, while one worker held old style nuts from turning.

Investigate the need for Midland Welding Nuts in your plant. Write or phone for complete information.

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Ave • Detroit 11, Mich.

Export Department 38 Pearl Street, New York, N. Y.

World's Largest Manufacturer of AUTOMOBILE and TRUCK FRAMES

Air and Vacuum POWER BRAKES

Air and Electro-Pneumatic DOOR CONTROLS

There are good ideas for you in this report on how to tackle the problem of . . .

MATERIALS SUBSTITUTION

This Special Editorial Report contains the latest available data on the serious problem of materials substitution. You will find this 24-page report an invaluable information source about:

The short and long-range outlook in metal and non-metallic materials

Examples of what some big companies are doing in materials substitution

Factors to consider when substituting one material for another

How plastics can be used as substitutes for strategic materials

Specific data on substitutes for steel and other critical metals

New developments in metals and how industry plans to use them

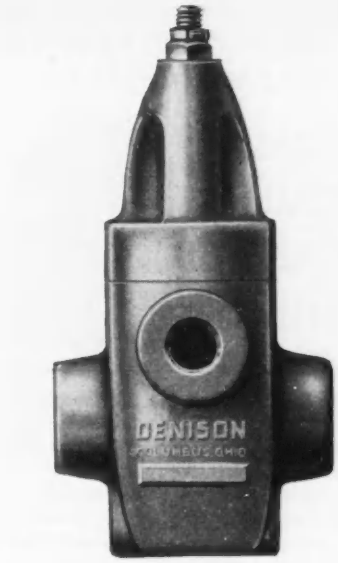
Copies available at 35 cents each.

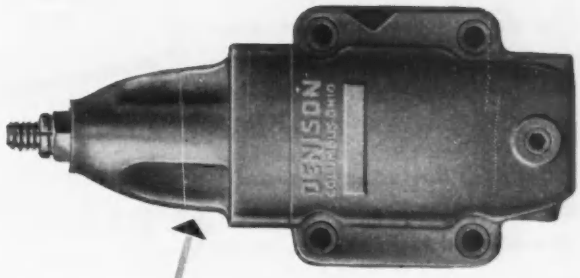
READER SERVICE DEPARTMENT

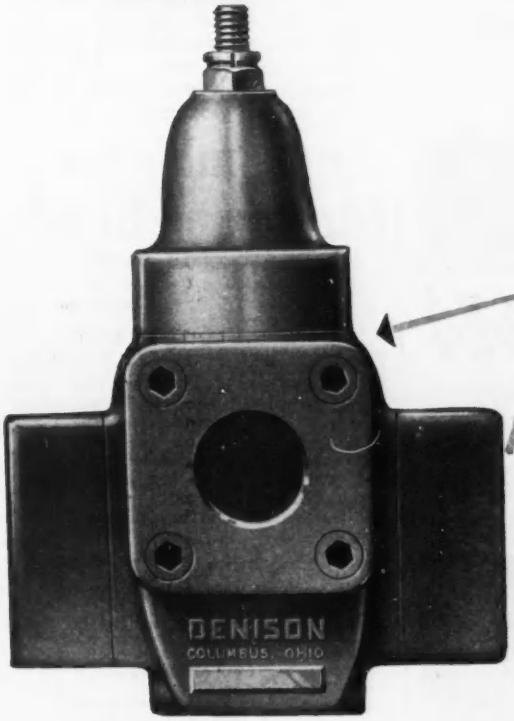
Product Engineering

McGraw-Hill Building

New York 36, N. Y.







New

DENISON *Direct-Operating* PRESSURE CONTROLS

An improved answer to a wide variety of relief, sequence, and unloading valve needs for systems up to 3000 psi. Denison's new direct-operating pressure control valves offer a control range up to 2000 psi, with *interchangeable* spools that are available either with or without a built-in check feature. Their simplified, cartridge-type design makes them unusually rugged, compact, easy to adapt to any circuit arrangement. Simplifies change-over . . . simplifies your inventory problems. 1/2", 3/4", 1 1/4" and 1 1/2" sizes with threaded body, subplate, or flange-type mountings. Write today for Bulletin VDA.

Direct-Operating Pressure Controls are another important step in Denison's continuing expansion of HydrOILic Pumps and Controls to cover all circuit requirements. For more than a quarter-century, Denison's research and development programs have gained higher performance standards for hydraulic equipment, adapting the full advantages of hydraulics to a wider range of needs . . . simplifying the components to provide ruggedness and precise control for today's high-performance systems. As a result Denison HydrOILic Equipment offers *proved* advantages for almost any hydraulic circuit. Write for full details.

"The Finest Money Can Buy!"

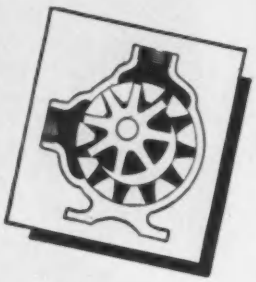
DENISON HydrOILics

The DENISON Engineering Co.
1157 Dublin Rd. Columbus 16, Ohio

NOT A SIDE-LINE

VIKING

BUILDS THE FULL LINE IN ROTARY PUMPS



The designing, testing, manufacturing and applying of Viking Rotary pumps is VIKING's one and only job.

What does this actually mean to you? It means that the energy, the development, and the output are at no time devoted to some other product.

The result is a superior rotary pump in a greater range of sizes and types to really fit your needs better.

Investigate the *complete* Rotary Pump line—VIKING. Start with bulletin 53SX.

See Our Catalog in SWEETS

Viking PUMP COMPANY
Cedar Falls, Iowa

A handy reference on formulas for...

- **STRESS**
- **STRAIN**
- **STRENGTH**

of materials

HERE'S your ideal guidebook on strength of materials. It contains extensive tables of formulas and numerous illustrative examples . . . includes the results of intensive analytical and experimental work . . . presents for your quick reference all the formulas for stress, strain, and strength useful to the design-engineer. It also brings you—*step-by-step*—the essential principles used in stress analysis, and provides you with fundamental data on the mechanical properties of materials.

Formulas for Stress and Strain

By RAYMOND J. ROARK
Professor of Mechanics, University of Wisconsin
366 pages, 6 x 9, 43 illustrations

SECOND EDITION, $5.00
PRODUCT DEVELOPMENT SERIES

This practical book takes you from basic definitions through clear statements of general principles, and right on to facts, figures and formulas for the calculation of stress and deflection. You get everything from the principles of superposition and least work to formulas for elastic stability of plates and shells.

Check the partial list of tables this guide puts at your fingertips:

—for straight beams, circular rings and flat plates under a wide variety of conditions of loading and support
—for curved beams and torsion members of various sections
—for thin- and thick-walled pressure vessels
—for rollers and other bodies under direct pressure
—for columns
—for slender bars and thin plates in which failure occurs through elastic instability.

SEE IT 10 DAYS—FREE

McGraw-Hill Book Co., Inc., 330 W 42d St., N.Y.36
Send me Roark's FORMULAS FOR STRESS AND STRAIN for 10 days' examination on approval. In 10 days I will remit $6.00, plus a few cents for delivery, or return the book. We pay for delivery if you remit with this coupon; same return privilege.

Name .....
Address .....
City ..... Zone.... State.....
Company .....
Position FPE-2-53
Books sent on approval in U. S. and Canada only.

Engineers

NEEDED to work on
AIRCRAFT TURBINE ENGINE DESIGN and DEVELOPMENT

ALLISON HAS IMMEDIATE OPENINGS FOR:
MECHANICAL ENGINEERS
AERONAUTICAL ENGINEERS
ELECTRICAL ENGINEERS
and LAYOUT MEN

If you'd like to know more about YOUR opportunity with ALLISON—and the many advantages awaiting the qualified engineer at ALLISON—investigate NOW. Send a brief summary of your education, work experience and qualifications—along with a recent photo—to:

R. G. GREENWOOD, *Salaried Personnel*
Dept. 155

Allison DIVISION GENERAL MOTORS CORPORATION • Indianapolis, Ind.

Design, development and production—high power TURBINE ENGINES for modern aircraft . . . heavy duty TRANSMISSIONS for Ordnance and Commercial vehicles . . . DIESEL LOCOMOTIVE PARTS . . . PRECISION BEARINGS for aircraft, Diesel locomotives and special application.

For the Production Engineer's Notebook—

Ideas for Welded Design

Product engineers, even the geniuses among them, find that the formula, "1% inspiration, 99% perspiration,"* pretty regularly applies.

Perspiration in design is brought about by the inevitable conflict between operating function—how well the part will do its job—and such other important factors as sales appeal, serviceability, and manufacturing methods.

What we are all striving for is to apply welding most economically. We in LINDE stand ready to help the product engineer in the applications of welding methods wherever we can. Sometimes economies in production come from a substitution of welding for more expensive methods, but often just a small change in design or practice reduces the cost of present welding operations.

Pointers on welded design leading to production economies.

Use the process that gives the greatest total economy.

Design for down-hand welding where possible. But locate welds so as to minimize handling.

Mechanize welding. Weld as many joints simultaneously as possible.

Make minimum dimension changes when making different sized models.

Reduce the number of parts. But sometimes it is better to increase the number of parts and cut rejects in intricate castings or formings by welding together simple forms.

Use standard shapes and easily formed sections.

Pointers on welding processes leading to production economies.

HELIARC welding: used for most metals—argon protects weld puddle. Minimizes cleaning and finishing costs. Manual, mechanized, and semiautomatic welding. Latter ideal for work on sheet materials with irregular contour.

Sigma welding: consumable electrode supplied as continuous coil of wire. Makes clean, smooth welds in practically all commercial metals at high rates of deposition, low costs, and high weld zone cooling rates.

UNIONMELT welding: high speed process for making deep-penetrated welds—butt, tee, lap fillets, plug—in most ferrous and non-ferrous metals. Usually mechanized, but also applicable by hand with flexible welder.

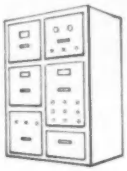
Take advantage of other economies that are inherent in such oxy-acetylene processes as flame-cutting, welding, surfacing, hardening. For more information on any of these processes call or write the nearest LINDE office today.

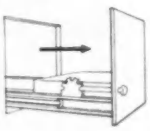
* "Genius is 1% inspiration and 99% perspiration," credited in GOLDEN BOOK, April, 1931, to a newspaper interview with Thomas A. Edison.

LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto
The terms "Heliarc" and "Unionmelt" are registered trade-marks.

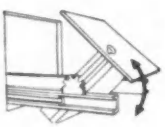
you tell us

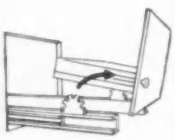
We design and manufacture the world's largest variety of industrial slides, used mainly today in electronic equipment. Pictured is a typical example, in which the slides provide easy access for servicing any component.





1. The component can slide out fully, easily. Sustains up to 200 pounds per pair. **2.** The component can be tilted and locked at any of several angles, up to plus 90° or minus 90°.



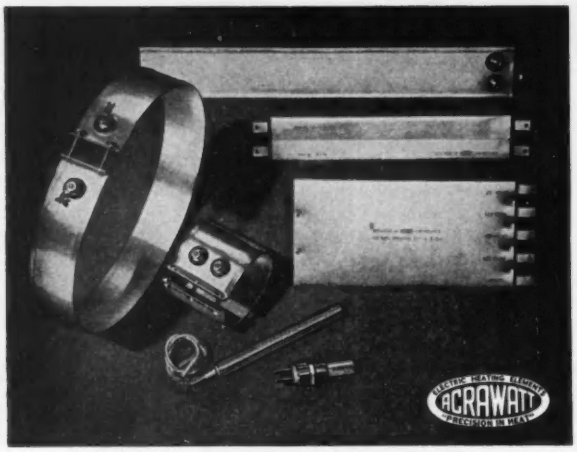


3. If desired, can be entirely removed and returned.

Does this suggest any new applications in your field? Tell us.

Grant Industrial Slides

a product of the engineering department of Grant Pulley and Hardware Co.
31-77 Whitestone Parkway, Flushing, N. Y.



specifying ELECTRIC HEATERS?

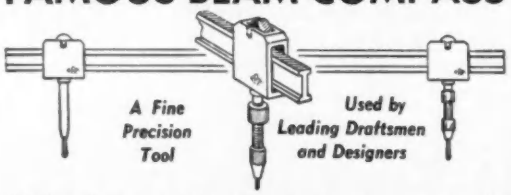
ACRAWATT Elements in any of the above forms may serve you well in your newly-designed product. Our specialty, however, is to make heating elements fitting your specific needs... whether for weight-saving or for cost-saving characteristics. Long runs and repetitive production are our strong points. Our experience and ability are recognized by many of America's leading engineers. Your inquiries are solicited.

"THINSTRIP" Reflexed Bands and Bars. Compacted Core Cartridges ... Immersion Heaters.

- RAPID HEAT TRANSFER
- LONGER LIFE
- LOWER COST

ACRA INDUSTRIAL ELECTRIC CO.
9907 PACIFIC AVENUE FRANKLIN PARK, ILL.

FAMOUS BEAM COMPASS



A Fine Precision Tool

Used by Leading Draftsmen and Designers

Hair-line adjustment quickly made and maintained by spring-loaded thumb rollers. No screws or clamps. Lead expeller for easy control of lead length. Slides instantly interchangeable to any beam length. Made of anodized aluminum, stainless satin finish. Beam lengths from 7" to 100". WRITE FOR LITERATURE.

ENGINEERING RESEARCH ASSOCIATES, INC.
3475 East Nine Mile Road Hazel Park, Michigan

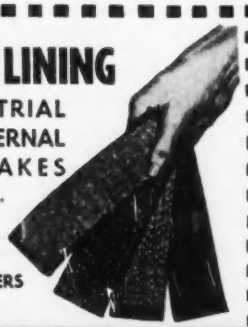
FOUR TYPES OF...

WOVEN BRAKE LINING

COVERING ALL INDUSTRIAL REQUIREMENTS FOR INTERNAL AND EXTERNAL BRAKES

sizes 1 1/2 x 5/32" through 4 x 3/8"

LARGE CAPACITY (10,000 ft. per Day)
LONG EXPERIENCE (since 1927)
SPECIALISTS IN SHORT RUN ORDERS



WE INVITE YOUR INQUIRIES

SOUTHERN FRICTION MATERIALS CO.
CHARLOTTE, N.C., U.S.A.

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT: "OPPORTUNITIES" :EQUIPMENT
BUSINESS: :USED OR RESALE

UNDISPLAYED —RATES— DISPLAYED

(Not available for equipment advertising)

$1.20 a line, minimum 4 lines. To figure advance payment count 5 average words as a line.

Individual Employment Wanted advertising rate is ½ the above rate, payable in advance.

Box Numbers—Care of publication New York, Chicago or San Francisco offices as one line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $10.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

New advertisements received in the N. Y. C. office by Jan. 19th will appear in the Feb. issue.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

EXPERIENCED DESIGNERS & DRAFTSMEN

Preferably experienced in diesel engine design or drafting. Salary open. Give full particulars on experience in first letter.

Beloit with a population of 30,000, is a city of homes and churches within 100 miles of Milwaukee and Chicago and in driving distance of the University of Wisconsin.

Permanent employment. Liberal personal benefits.

Fairbanks, Morse & Co.
Beloit, Wis.

SALES AGENTS

LARGE EASTERN SINTERED PARTS PRODUCER HAS OPEN TERRITORIES—

OUR AGENTS KNOW OF THIS AD

Send Complete Data To

RW-6402, Product Engineering
330 W. 42 St., New York 36, N. Y.

MECHANICAL ENGINEERS

We are looking for mechanical engineers, with experience in the design of small intricate mechanisms, to work in the development of business machines. Plenty of opportunities for advancement.

Write, giving full details, including education and experience.

THE NATIONAL CASH REGISTER COMPANY
South Main and "K" Streets
Dayton 9, Ohio

MANAGER
MACHINE DESIGN DEPARTMENT

Top Engineer with experience in design and development of special machinery for tire industry. Must be inventive and familiar with complex machinery involving mechanical and electrical devices to reduce manual operations. Will direct large staff of designers and contact management on special design problems. Give full details covering experience, age, education, etc.

P-6601, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

MECHANICAL ENGINEER

Experienced, for design and production engineering with leading manufacturer of small electrical components and control devices. Attractive conditions, good opportunity. State full details including salary desired.

P-6572, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

ADDITIONAL POSITIONS VACANT ADVERTISING

ON PAGES 452, 453 & 454

WANTED
DISTINCTIVE PRODUCT OR BUSINESS

Our client, an established Eastern manufacturer, will prefer special-purpose machines or machinery of medium size, selling

1. To general industrial markets, or
2. To automotive repair shops

High precision manufacture—market acceptance established—sales potential $500,000 a year and up.

Please write referring to advertisement No. 48. Brokers protected.

We are compensated by our client.

CHARLES H. WELLING & Co.
INC.
52 Vanderbilt Ave. New York 17, N. Y.

POSITION VACANT

ASSISTANT SAFETY Engineer. Graduate mechanical, emphasis on explosives, 5 years industrial experience in pyrotechnics or blasting activity preferred. Advancement assured for man who qualifies. Give complete resume and salary expected. P-6693, Product Engineering.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection, under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. H, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

ENGINEERING EXECUTIVE — Chief designer for prominent producer of gear manufacturing machinery desires similar position with progressive organization. 30 years background of engineering and administrative experience. Age 50. PW-5707, Product Engineering.

PATENT LAWYER experienced in electronic and electrical arts, over 3½ years corporate patent law practice, four years engineering design experience, excellent scholastic record, desires connection with small or medium size patent organization. Address PW-6544, Product Engineering.

REGISTERED ELECTRICAL Engineer. 14 years practical and professional experience, 9 years in electric motor industry, 5 years in government service. Research, design, and administration, no tool design. Capable chief engineer or assistant for small, aggressive engineering department. Describe your opening and request particulars from PW-6716, Product Engineering.

TOP LEVEL executive position as Director of Research, Manager of Engineering, Chief Engineer, Factory Manager or Ass't. with medium size firm with direct responsibility to management. Exceptional background with training and experience in all phases of engineering and manufacturing. Twenty years experience in optical instruments, business machines and precision special machinery. Salary in five figure bracket. Comprehensive resume submitted on request. Prefer medium size city near metropolitan area anywhere in New England. PW-6735, Product Engineering.

QUALITY CONTROL Manager 23 years industrial background. Thoroughly versed in manufacturing techniques, including personnel, cost accounting and statistical quality control on a management level, desires responsible permanent connection. Married. Age 45. Midwest preferred. PW-6633, Product Engineering.

NEW ENGLAND SALES AGENCY

A leading agency covering the metal working field in New England desires an additional line of industrial parts. Preference: Die castings, permanent mold castings, plaster mold castings, powder metal or plastic parts. In addition to experienced sales engineers in the field, it has competent engineering department. Only a producer of quality parts will be considered.

RA-6707, Product Engineering
330 W. 42 St., New York 36, N. Y.

PATENT AVAILABLE with UNIVERSAL APPLICATIONS

Throughout entire metalworking industry. Revolutionary device offers great savings in labor. Patent covers broad use as: nut, lock-unit, collar, adapter, etc.

SS-6726, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

CONTRACT WORK

SEE PAGE 454

MECHANICAL
Engineers
for design work in

- SERVOS
- PRECISION GEARING
- MECHANISMS
- RADAR EQUIPMENT PACKAGING
- RADAR ANTENNAS
- SPECIAL TRUCK BODIES

ON LONG-TERM ENGINEERING PROJECTS • DEGREE OR EXPERIENCE REQUIRED

Write Today

GILFILLAN BROS., INC.

Los Angeles 6, California

AUTOMATIC GCA • AIRPORT TRAFFIC CONTROL RADAR
GUIDED MISSILES • RADAR COUNTERMEASURES

CAREER OPPORTUNITIES

ENGINEERS and PHYSICISTS

Desiring the challenge of interesting, diversified, important projects —
Wishing to work with congenial associates and modern equipment and facilities —
Seeking permanence of affiliation with a leading company and steady advancement —
Will find these in a career here at GENERAL MOTORS.

Positions now are open in ADVANCED DEVELOPMENT and PRODUCT DESIGN, INDUSTRIAL ENGINEERING, TEST and TEST EQUIPMENT DEVELOPMENT.

COMMERCIAL AUTOMOBILE RADIO
MILITARY RADIO, RADAR AND ELECTRONIC EQUIPMENT
ELECTRONIC COMPONENTS
TRANSISTORS AND TRANSISTOR AND VACUUM TUBE APPLICATIONS
INTRICATE MECHANISMS such as tuners, telemetering, mechanical linkage, controls, etc.
ACOUSTICS—loud speakers, etc.

Inquiries invited from recent and prospective graduates as well as experienced men with bachelors or advanced degrees in physics, electrical or mechanical engineering, chemistry, metallurgy.
Salary increases based on merit and initiative.
Vacations with pay, complete insurance and retirement programs.
Location is in a low living cost center.
Relocation expenses paid for those hired.

All inquiries held in confidence and answered—WRITE or APPLY to

DELCO RADIO DIVISION
GENERAL MOTORS CORPORATION
Kokomo, Indiana

DRAFTSMEN
Experienced for work on heavy machinery
Permanency and Opportunity
For appointment, call or write
ELLICOTT MACHINE CORP.
1611 Bush St. Baltimore 30, Md.
GI. 7600

MECHANICAL ENGINEER
To handle wide variety of problems, principally in machine design, but knowledge of electrical practice and thermodynamics desirable. Wide variety of problems to be detected, analyzed, and solved by man working under minimum of supervision. State details of education and experience.
P-6441, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Position Open for Junior Editor

Product Engineering has a position open on its staff for a young engineering graduate with a few years industrial experience in product design or metallurgy. The job is permanent, prospects for advancement are excellent for an engineer seeking an editorial or publishing career. Working facilities and associates are top level.

Some writing experience is preferred. Applicant also must have pleasant personality and develop ability to converse with upper echelon engineering executives.

Training courses on company time in writing and editing will be part of the job.

McGraw-Hill personnel policies include excellent working conditions, generous vacations, retirement program, group and health insurances, and many other desirable features.

All applications will be answered.

Write, stating salary, to
George F. Nordenholt, *Editor*

PRODUCT ENGINEERING
McGRAW-HILL PUBLISHING COMPANY
330 West 42nd Street
New York 36, New York

Methods, Process Engineers

you can profit from this challenge

If you're an experienced methods or process engineer who's looking for a change that spells c-h-a-l-l-e-n-g-e, one of many big openings at Honeywell might fit you.

What we face is the realization by industry that "the prime force behind the 20th century industrial revolution *is* automatic control."

It's taxing our production. It's why we have a real need for "engineers of production."

Duties of the jobs. Figure ways to make quality products at minimum cost. Supervise the tooling, processing and planning necessary to transform blueprints into finished products.

Requirements. B. S. or M. S. in Mechanical, Electrical, Industrial or Chemical Engineering.

Atmosphere. A company which is growing rapidly, steadily and soundly. The challenge of production is ever present.

Openings. In Minneapolis and Philadelphia.

For details write H. D. Elverum, Personnel Dept. PE-2-13, Honeywell, Minneapolis 8, Minnesota. And be sure to ask for our new book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

First in Controls

We desire personnel of the highest caliber—experienced in the field of airborne automatic electro-mechanical control equipment.

★

ENGINEERS

MECHANICAL DESIGN
ELECTRONIC
SERVO

DESIGNERS-LAYOUT MEN

ELECTRONIC
MECHANICAL

This work deals with the manufacture and development of highly complex equipment of the most advanced type in a new and expanding division of an established firm with 20 years of successful experience in the precision instrument field.

We cite a few of the good reasons why you might like to join our organization . . .

SALARY increases are based on merit and initiative—two weeks VACATION, HOSPITALIZATION BENEFITS, GM's own INSURANCE PLAN—POSITIONS ARE PERMANENT due to long range manufacturing and developing programs—EXPENSES incident to interviews and moving all absorbed by company—HOUSING and LIVING CONDITIONS among the best and finest of any along Lake Michigan.

- **We have a Junior Engineering Training Program of one year for inexperienced engineering graduates. Opportunity to become acquainted with all phases of industry.**
- **For the convenience and direct use of engineers in our Engineering Department, we have our own model shop where highest skilled mechanics are employed.**
- **Educational opportunities for advanced degrees available at U. of W., Marquette. Technical engineering offered at Milwaukee Vocational School.**

. . . all inquiries answered—write or apply . . .

★ AC SPARK PLUG DIVISION

GENERAL MOTORS CORPORATION

1925 E. KENILWORTH PL. **MILWAUKEE 2, WIS.**

DESIGNER ON SMALL MECHANISMS

Research design of small intricate mechanisms, mostly design layout work requiring ingenuity and originality. 5 years experience in the small mechanism field is essential with a B.S. degree in M.E. a definite asset.

This position offers advancement and stability with a rapidly growing firm, established as a producer of accurate small mechanisms for both business and military purposes. Write to Mr. Winker or call Ke. 9-8210, Chicago.

VICTOR ADDING MACHINE CO.

3900 N. Rockwell, Chicago 18

ENGINEERS AND PHYSICISTS

BS–MS–Ph.D:

Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential.

Ind. Rel. Manager,
Research & Development Dept.

PHILLIPS PETROLEUM COMPANY

Bartlesville • Oklahoma

YOUR FUTURE IS YOURS AT AS A DESIGN ENGINEER

- **WHO** will be working on basic design of metal working and hydraulic machinery . . .
- **AT** one of the leading manufacturers of machine tools and hydraulic equipment . . .
- **IN** Rockford, a friendly city within 90 miles of metropolitan Chicago.

This will be a permanent position with a highly progressive company, having substantial insurance and pension programs. . . . Send us a post card asking for an application.

SUNDSTRAND
MACHINE TOOL CO.
ROCKFORD - - - - - - - ILLINOIS

POWDER METAL TOOL DESIGNER

RARE OPPORTUNITY TO ADVANCE TO TOP POSITION IN LARGE PARTS FABRICATING PLANT. EASTERN LOCATION TRANSPORTATION, MOVING, AND OTHER COSTS WILL BE PAID. SEND COMPLETE RESUME.

P-6405, PRODUCT ENGINEERING
330 W. 42ND ST., NEW YORK 36, N. Y.

MECHANICAL ENGINEERS
MECHANICAL DESIGNERS
DRAFTSMEN

To design small intricate mechanisms to be used in business machines for commercial applications. Excellent working conditions, good salaries, and exceptional employee benefits. Write, giving full details including education and experience. Personal interviewers will be arranged.

THE NATIONAL CASH REGISTER COMPANY
MAIN AND K STREETS — DAYTON 9, OHIO

AVAILABLE FOR IMMEDIATE DELIVERY:

One 2-Mev Van de Graaff Generator, output 140-r per minute at 70 cm., inherent filtration equivalent to 6 mm. lead. Rugged construction, stable and dependable output. Suitable for industrial radiography, for research (particularly where an electron current greater than 400 microamperes is desirable), or for radiation therapy.

Can readily be converted to proton or deuteron accelerator.

Offers and bids welcomed. Will consider exchange for equipment or materials needed for hospital expansion program.

Further details, photographs, or blueprints available on request.

FS-6531, Product Engineering
1111 Wilshire Blvd., Los Angeles 17, Calif.

ENGINEERS AND DESIGNERS

With creative ability and a sincere interest in stable employment wanted by a medium size well-known machine tool company. Openings exist in research, machine design and equipment design divisions due to present and projected design of new products. Applicants with working knowledge of machine hydraulics, servo-mechanisms and electrical components desired. Company is located in a pleasant, progressive New England village having good recreational facilities, modern schools, hospital, etc. Excellent working conditions and congenial atmosphere. Send resume to

P-6610, Product Engineering
330 W. 42 St., New York 36, N. Y.

PROFESSIONAL SERVICES

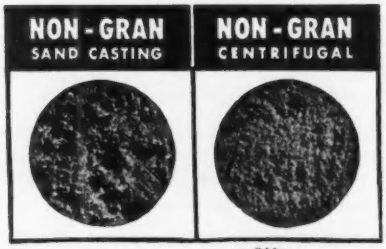
GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies: Process or Product Redesign Existing Products for Greater Profit. Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery, Process, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies
P. O. Box 3 *(Est. 1923)* Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

NEW YORK TESTING LABORATORIES, INC.
CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY
Analysis, Tests of all Materials and Products, Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design
80 Washington St. New York City 6, N. Y.

SKINNER, HARLAN AND IRELAND, INC.
Consulting Engineers
Specializing in Magnetic Materials and Their Application
Office and Laboratory Indianapolis 7, Indiana

CONTRACT WORK

Can these two pictures SAVE YOU MONEY?



For complete information write, phone or wire
American Non-Gran Bronze Co.
Berwyn, Pa.

PRECISION MACHINE WORK
NON-GRAN
CASTINGS • SAND & CENTRIFUGAL

10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order
EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

Index of

PRODUCTS ADVERTISED

In This Issue

•

MATERIALS

Adhesives 84
Aluminum Alloys 35, 70, 92-93, 214 275, 375
Bimetal 70, 309
Brass 2, 441
Bronze 2, 309, 369
Carbon 331
Carbon Graphite .....4th Cover
Ceramics 95, 279
Chemicals 388
Copper Alloys 70, 94, 309, 441
Cork Compositions 69, 96, 459
Fabrics, Coated or Impregnated 386
Felt 326
Fibre 361, 383, 427
Friction Materials 106-107 295, 450
Glass 307, 365, 388, 401, 427
Graphite 331
Laminated Metals 70
Leather 224
Light Metals 418
Manganese Alloys 70
Molybdenum Alloys 2, 394
Nickel Alloys 99, 100, 423
Nylon 71
Plastics 6, 71, 80, 103, 212, 313, 314 353, 377, 383, 388, 390, 393, 425
Plastics, Laminated .361, 383, 425
Platinum Alloys 70
Powdered Metals ...4th Cover, 309 321, 335
Resins 353
Rubber & Synthetics 26-27, 80, 96 259, 260, 296, 308, 417
Silicones 210
Silver Alloys 4, 70
Stainless Steel .2nd Cover, 78, 100 112, 297-300
Steel ..24, 214, 233, 235, 241, 263 273, 285, 297-300
Titanium 4, 315
Tool Steel 297-300
Wood 316
Zinc 12

STRUCTURAL PARTS

Bars 35, 297-300, 406
Bushings 309, 406
Castings 99, 294, 328, 358, 360, 394 409, 435, 445
Die Castings ..61, 66, 280, 420, 429
Expanded Metals 282
Extrusions 35, 436
Forgings ..35, 52-53, 275, 285, 320
Metal Powder Parts 4th Cover, 309 321, 335
Plates 297-300
Rods 393, 441
Shapes ...35, 273, 297, 300, 372, 410
Sheets ..35, 112, 297-300, 393, 417 423, 441
Stampings 246, 387, 442
Strips 2nd Cover, 263, 297-300, 423
Tubing ..16, 35, 78, 92-93, 235, 241 256, 297-300, 324, 389, 393, 410 414, 416, 441
Wire 14, 48, 297-300, 441

FINISHES

Galvanizing 398
Metal Spraying 398
Non-Metallic 402
Paints & Lacquers 229, 258 341, 388
Plating 386
Rust Proofing 46-47, 258, 386

(Continued on Page 456)

8 Basic Features OF EVERY HAYDON TIMING MOTOR PROVIDE

PRECISION TIMING • JOB ENGINEERED FOR *Outstanding Performance*

1

DEPENDABILITY

Slow rotor speed means a minimum of reduction gearing, long life, quiet operation.

2

SMALL SIZE

HAYDON motors are the smallest available of their types.

3

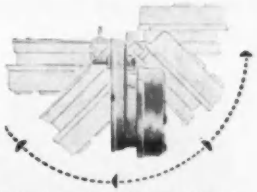
TOTAL ENCLOSURE

ALL HAYDON motors are totally enclosed, a basic feature of sound design.

4

CONTROLLED LUBRICATION

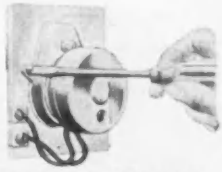
Two lubrication systems permit the selection of lubricant best suited to each component. All circulation controlled by capillary action.



5

OPERATION IN ANY POSITION

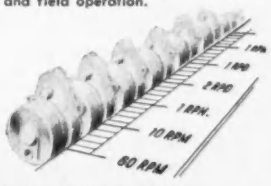
Means freedom from worry about mounting position, no limitations on your original design and field operation.



6

SIMPLE SECURE ASSEMBLY

The entire face of the motor can be rigidly supported against the mounting surface. Motor leads are standard for quick, inexpensive wiring.



7

STANDARD INTERCHANGEABLE DESIGN

A wide range of speeds in only 2 motor series, interchangeable in mounting, drive shafts and all dimensions except depth, permits use of the same basic motors for a variety of requirements.

8

CHOICE OF MANY SPEEDS

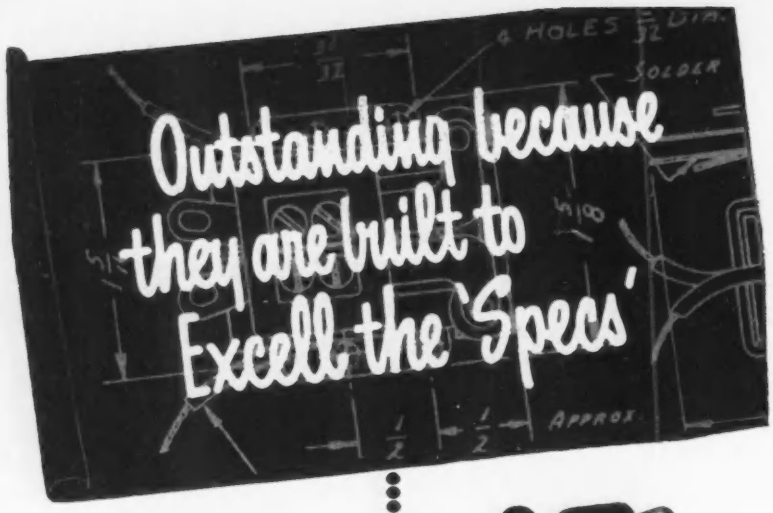
Many standard speeds available from 60 rpm to 1 revolution per week.

Look to **HAYDON** AT TORRINGTON

FOR TIMING MOTORS • TIMING DEVICES
TIMING ENGINEERING SERVICES

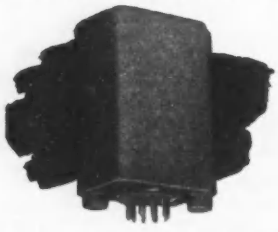
HEADQUARTERS FOR TIMING

3126 Elm St., Torrington, Conn. Subsidiary General Time Corp.



R 45 SERIES—Small telephone type relay with pin hinge construction. Available with multiple contact springs up to six pole double-throw. Capacities: 1 amp., 3 amp., or 5 amp. Normally supplied for D.C. operation. Hermetically sealed or open. 1-13/32x1-1/4x1-7/32 to 1-5/8 high.

R 83 SERIES—Available with A.C. or D.C. coils. Contact ratings up to 30 amperes continuous, 150 amperes inrush with single pole double-break arrangement. Multiple contact springs with proportionately lower ratings also available. Size: 1-7/8x1-5/16x1-5/8 high.



R 94 SERIES—Hermetically sealed small telephone type relay with pin hinge construction for long life. Available in D.C. only with contact springs up to 4 pole double-throw. In 1 amp., 3 amp., or 5 amp. capacity. Plug-in or solder terminals. Overall size 1-5/8 x 1-1/32 x 2-1/4 D.

RB 45 SERIES—Similar to R 45 with the exception that it is designed to fit the hermetically sealed enclosure shown. Three stud mounting; solder terminals. Available up to 4 pole double-throw. Widely used in aircraft and ground communication equipment. Size: 1-5/8 x 1-7/16x2-1/32 D.

"Diamond Quality" TIME SWITCHES...

Automatic Electric also produces a complete line of Time Switches and Timers, both manual and automatic reset. Write for information.

AEMCO

Automatic Electric MFG. CO.

66 STATE STREET MANKATO, MINN.

Index of PRODUCTS ADVERTISED

In This Issue

•

(Continued from Page 455)

MECHANICAL PARTS

Adhesives 84
Axles 340
Balls 302, 438
Bearings, Ball, Roller & Needle 22-23, 50-51, 56, 83, 86 91, 97, 118, 231, 237, 261, 318, 322 378, 397, 404, 431, 434
Bearings, "Oil-less".....4th Cover 321
Bearings, Sleeve ...4th Cover, 309 321, 369, 406
Bellows 10, 49, 114
Belts 15, 31-34, 351, 457
Bolts, Nuts, Screws & Rivets 28-29 37, 44, 64, 75, 79, 116, 219, 243 248, 301, 310, 312, 320, 337, 350 352, 376, 408, 438, 446
Blowers 434
Brakes 42-43, 395
Brushes 388
Bushings & Grommets..... 323
Chains ...11, 13, 45, 267, 268, 314
Clamps 373, 396
Clips 386
Clutches ..88-89, 265, 350, 388, 395 444
Compressors 31-34, 384
Containers 372
Controls 281, 316, 354, 447
Counters 17, 342
Couplings, Flexible ...82, 104, 288 342, 460
Couplings, Hose & Tube ..25, 373
Dampers 244
Drives .11, 31-34, 98, 104, 349, 351
Engines 269, 292, 311, 357, 371
Fasteners ...28-29, 37, 44, 55, 59 64, 75, 79, 116, 219, 243, 248, 293 301, 310, 312, 320, 337, 352, 376 380, 400, 408, 419, 438, 442, 446
Feeders .....30 B, 396
Filters 249, 461
Flexible Joints 399
Floats 276
Gages & Instruments..... 346
Gears ..105, 250-251, 316, 356, 382 424, 426
Hose 15, 25, 114, 329, 430
Hydraulic & Pneumatic Equipment.1, 25, 42-43, 60, 98, 249, 253 278, 281, 286, 289, 316, 325, 338 354, 370, 376, 379, 413, 447
Insulation 401, 427
Knives & Blades..... 407
Locks, Hinges 320
Lubricating Equipment .8, 85, 304 422, 464
Mountings 244, 460
Name Plates 422, 434
Packings, Gaskets & Seals 4th Cover, 15, 54, 69, 96, 224, 257 272, 287, 290, 302, 305, 308, 342 355, 386, 391, 440
Photographic Equipment 245
Piping 297-300
Power Units 60, 286, 349, 354, 371
Pumps ...31-34, 278, 286, 289, 304 327, 338, 349, 415, 418, 448
Rings ..4th Cover, 55, 285, 342, 350 359, 391, 419
Shafting, Flexible 463
Sheaves & Pulleys 31-34
Shims 247
Slides 450
Speed Reducers & Motor Reducers ...3rd Cover, 18, 21, 31-34 41, 104, 252, 254, 274, 330
Spindles 385
Springs 333-334, 422
Sprockets 276, 323
Testing Equipment 435
Tapes 459
Timers 20-21, 378
Transmissions 444
Traps 276
Universal Joints 254, 292, 458

Index of

PRODUCTS ADVERTISED

In This Issue

Valves & Fittings ..1, 8, 42-43, 221 255, 276, 281, 304, 316, 319, 329 332, 347, 370, 376, 396, 413, 421 447
Vibratory Equipment 433
Vibration Dampers ..244, 433, 460
Washers 309
Wheels & Castors..... 376
Wire Cloth 428, 457

ELECTRICAL PARTS

Assemblies 95
Brakes 62-63, 254
Brushes .....4th Cover
Clutches 62-63
Connectors 317, 380, 403
Contacts ...18-19, 70, 81, 278, 284 420, 424
Controls & Control Equipment..18-19 31-34, 58, 65, 67-68, 76-77, 87 101-102, 223, 266, 284, 286, 312 339, 363, 367-368, 439, 443, 456 462
Cords 271
Counters 342
Couplings 104
Drives 98, 105, 252
Electronic Equipment 95, 374, 392
Extruded Plastics 239
Fans & Blowers..... 363
Heating Units 20-21, 339, 450
Instruments 306, 374, 392, 437
Insulation 239, 314, 361, 401
Lamps 412
Magnetos 348
Motors ...3rd Cover, 18-19, 30-30A 31-34, 36, 38-39, 41, 57, 82, 90 252, 254, 264, 277, 283, 291, 345 363, 364, 381, 392, 405, 411, 424 437, 444, 455
Solenoids 266, 332, 416, 462
Thermostats 74, 227, 431
Timers 36, 57, 277, 378, 455
Wire & Cable..... 271
Wiring Accessories ..271, 343, 403 438

DRAFTING ROOM EQUIPMENT AND SUPPLIES

245, 262, 288, 396, 418, 432, 450

FABRICATING METHODS AND SERVICES

Die Casting 332
Drawing 40, 398
Enameling 398
Extruding 259
Forming 40, 308, 398
Grinding 382
Molding ..6, 259, 260, 296, 308, 336 390
Plating 4, 40
Rolling 410
Spinning 436
Stamping 40
Swaging 268
Welding ...270, 303, 344, 398, 449

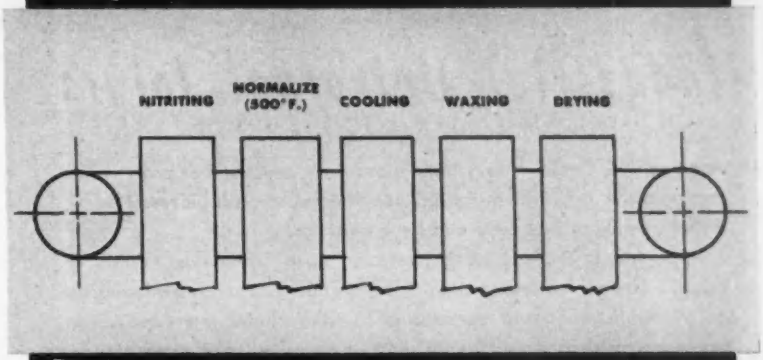
ENGINEERING & PRODUCTION SERVICES

253, 281, 308, 311, 331, 344, 362 375, 398, 400, 410, 425

BOOKS

72-73, 246, 328, 332, 392

CAMBRIDGE WIRE MESH BELTS . . .



help spring producer boost output 350% in 30% less floor space!

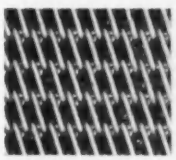
110 old-fashioned hand trucks no longer needed! 15 truck operators freed for more productive work! Floor space requirements cut by 30%. Output rose from 290,000 pieces in 24 hours to 680,000 pieces in 16 hours, *an hourly increase of 350%!*

These were the results of this installation of a 98′ Cambridge wire mesh belt in a large spring producing plant. The moving belt gives continuous production, eliminates the need for hand trucks in transferring the work from one step to the next, assures uniformly processed work.

Perhaps Cambridge wire mesh belts can help you get similar savings. They're available in any metal or alloy, mesh or weave, length or width. They can be used under practically any conditions . . . from temperatures as high as 2100° F. down to sub-zero, for handling work through simple water rinses or highly corrosive acid sprays, for carrying small delicate parts or heavy, bulky loads. All-metal belt construction assures long life and freedom from damage. Open mesh permits free drainage of process solutions or free circulation of process atmospheres.

WHY NOT CALL IN YOUR CAMBRIDGE FIELD ENGINEER?

You can rely on his experienced advice to recommend just the right type of wire mesh belt for your process. Look under "Belting-Mechanical" in your classified phone book for the Cambridge office nearest you.



Cambridge Duplex Weave, one of the most widely used specifications for continuous heat treating.

FREE BELT MANUAL tells how Cambridge belts can be used in your industry. Also includes useful data on conveyor design, metallurgical tables and belt specifications. Write for your copy today.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P
Cambridge 2, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Single or Double...

APEX Heavy-Duty

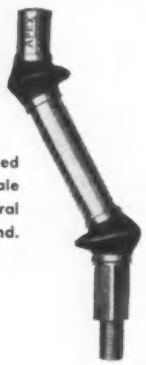
Industrial Universal Joints

Apex #300 Series Heavy-Duty Industrial Joints embody the same service-proved designs and structures of Apex aircraft universal joints, differing only in materials and heat treatment.

Available in thirteen stock sizes, ⅜" to 4" diameters, single or double. Sealed, lubricant-retaining covers insure superior performance on all applications and particularly so where joints are exposed to water, corrosive gases or liquids, dust or abrasive-laden atmospheres.

Apex #300 Series universal joints, in all sizes and types, can be built to order from bronze alloys, stainless steels or other special materials. For unusually severe service conditions, Apex can furnish universal joints with special treatment to provide even longer service life than normally expected of standard heavy-duty universal joints.

TYPICAL APEX UNIVERSAL JOINT ARRANGEMENTS



Double universal with long, fixed connector, having special male square and threaded integral extension and standard hub end.

Double universal with long, fixed connector and varying hub ends bored for pinning.

Double universal with short, fixed connector, identical hub ends, with either female squares, hexes, splines or keyways.

Double universal with axially-free extended square inset with extension stop, and hub ends arranged with either internal threads or female squares, hexes, splines or keyways.

Double universal with tapped hubs, with long, small-diameter, lubrication-retaining cover.

APEX universal joints

THE APEX MACHINE & TOOL COMPANY
1039 S. Patterson Blvd. • Dayton 2, Ohio

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Acme Chain Corp. 314
Acme Tank & Welding Div. United Tool & Die Co. 270
Acra Industrial Electric Co. ... 450
Acushnet Process Co. 260
Adams and Westlake Co. 223
Adel Div. General Metals Corp. 370
Advance Electric & Relay Co. 312
Aeroquip Corp. 329
Aetna Ball & Roller Bearing Co. 237
Aircraft-Marine Products Co. . 343
Alden Products Co. 278
Alemite 85
Allegheny Ludlum Steel Corp. . 24
Allen-Bradley Co. 67-68
Allen Mfg. Co. 337
Allied Research Products Inc. . 386
Allis-Chalmers Mfg. Co. 31-34
Allison Div. General Motors Corp. 448
Aluminum Goods Mfg. Co. 375
American Blower Corp. 98
American Chemical Paint Co. 258
American Hard Rubber Co. ... 296
American Insulator Corp. 336
American Lava Corp. 279
American Nickeloid Co. 423
American Screw Co. 44
American Steel Foundries Level Load Axle Div. 340
American Welding & Mfg. Co. 344
Amplex Mfg. Co., Div. Chrysler Corp. 321
Anchor Coupling Co., Inc. 373
Apex Machine & Tool Co. 458
Arkwright Finishing Co. 262
Armco Steel Corp. 214
Armstrong Cork Co. ...69, 96, 459
Arrow-Hart & Hegeman Electric Co. 101-102
Arwood Precision Casting Corp. 445
Associated Spring Corp. 333-334
Atlantic Casting & Engineering Corp. 394
Atlantic Screw Works. 44
Automatic Electric Mfg. Co. ... 456
Avco Mfg. Corp., Lycoming-Spencer Div. 311

Bakelite Co. Div. Union Carbide and Carbon Co. 377
Baldwin-Lima-Hamilton Corp. Standard Steel Div. 285
Bantam Bearings Div., Torrington Co. 91
Barry Corp. 244
Bead Chain Mfg. Co. 268
Belden Mfg. Co. 271
Belgian Electric Sales Corp. .. 90
Bethlehem Steel Co. 273
Blake & Johnson Co. 44
Boston Gear Works. 323
Brainard Steel Div. Sharon Steel Corp. 241
Breeze Corporations, Inc. 317
Bridgeport Brass Co. 94
Briggs & Stratton Corp. 269
Brown & Sharpe Mfg. Co. 306
Bruning Co., Inc. Charles. 432
Buffalo Bolt Co., Div., Buffalo Eclipse Corp. 389
Bundy Tubing Co. 248
Bunting Brass & Bronze Co. ... 406

Cambridge Wire Cloth Co. 457
Cameron Iron Works, Inc. 52-53
Carpenter Steel Co. 100
Carpenter Steel Co., Alloy Tube Div. 78
Cash Valve Mfg. Corp., A. W. 319
Central Screw Co. 44
Chain Belt Co. 45
Chase Brass & Copper Co., Inc. 441
Chicago Forging & Mfg. Co. .. 347
Chicago Rawhide Mfg. Co. 224
Chiksan Co. 399

INDEX TO ADVERTISERS

Chrysler Corp. Industrial Engine Div. 371
Ciba Co., Inc., Araldite Div... 353
Cincinnati Gear Co. 424
Clearprint Paper Co. 418
Cleveland Cap Screw Company 312
Clifford Mfg. Company 10
Climax Molybdenum Co. 394
Columbia-Geneva Steel Div. 297-300
Cone Drive Gears Div., Michigan Tool Co. 250-251
Consolidated Engineering Corp. 374
Continental-Diamond Fibre Co. 383
Continental Rubber Works... 308
Continental Screw Co. 44, 219
Corning Glass Works 307
Cramer Co., Inc., R. W. 277
Crane Co. 221
Crane Packing Co. 272
Curtis Universal Joint Co. 254
Cuyahoga Spring Co. 422

Dearborn Glass Co. 365
DeLaval Steam Turbine Company 327
Delco Products Div., Gen Motor Corporation 345
Denison Engineering Co. 447
Detroit Coil Co. 416
Dial Light Co. of America 412
Diefendorf Gear Corporation .. 316
Dodge Mfg. Corporation 330
Doerr Electric Corp. 392
Dollinger Corporation 249
Dow Corning Corp. 210
duPont deNemours & Co., Inc., Electrochemical Department 341
duPont deNemours & Co., Inc., E. I. (Neoprene) 26-27
duPont deNemours & Co., Inc., E. I., Pigment Dept. 315
duPont deNemours & Co., Inc., E. I. (Plastics) 71
Durakool, Inc., ... 286
Dynamatic Corp., subs. Eaton Mfg. Co. 104

Eagle Lock Co. 44
Eastern Tool & Mfg. Co. 40
Eastman Kodak Co., Industrial Optical Sales Div. 346
Eastman Kodak Co., Industrial Photographic 245
Eastman Mfg. Co. 25
Eaton Mfg. Co. (Dynamatic Corp.) 104
Elastic Stop Nut Corp. of America 79
Elco Tool & Screw Corp. 44
Electric Auto-Lite Co. 212
Electric Wheel Co. 376
Electro Film Corp. 422
Elliott Co. 82
Emerson Electric Mfg. Co. .. 363
Engineering Research Assoc. .. 450
Enthone, Inc., ... 402

Fairchild Aircraft Div. Engine And Airplane Corp. 444
Farval Corp. 8
Fasco Industries, Inc. 264
Fawick Airflex Co., Inc. 395
Federal Bearings Company, Inc. 23
Federal Mogul Corp. (Equipment) 309
Federal Tool & Mfg. Co. 442
Felters Co. 326
Fenwal, Inc. 439
Flexonics, Corp. 114
Foote Bros. Gear & Machine Corp. 105
Ford Motor Co., Industrial Engine Dept. 357
Formsprag Co. 88-89
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. .. 49
Funk Aircraft Co. 444

Garlock Packing Co. 440
Gast Mfg. Corp. 286
Gates Rubber Co. 351

(Continued on page 460)

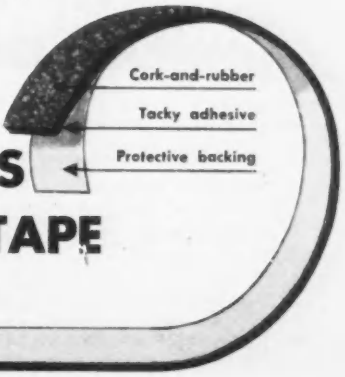
Cork-and-rubber tape seals as it cushions

Here's a tape you can use to seal as well as to cushion. Locomotive builders, for example, use Armstrong's DK-153 Tape as a watertight gasket between the outside metal panels and the frame of the locomotive.

DK-153's resilient cork-and-rubber composition literally "soaks up" the vibration. In addition, it keeps water and dirt from penetrating the joint. This is but one example of the difficult jobs being done by this remarkable tape.

DK-153 is quick and easy to apply. Just strip off the cloth backing and press the tape into place. Its pressure-sensitive adhesive sticks tight to any clean, dry surface.

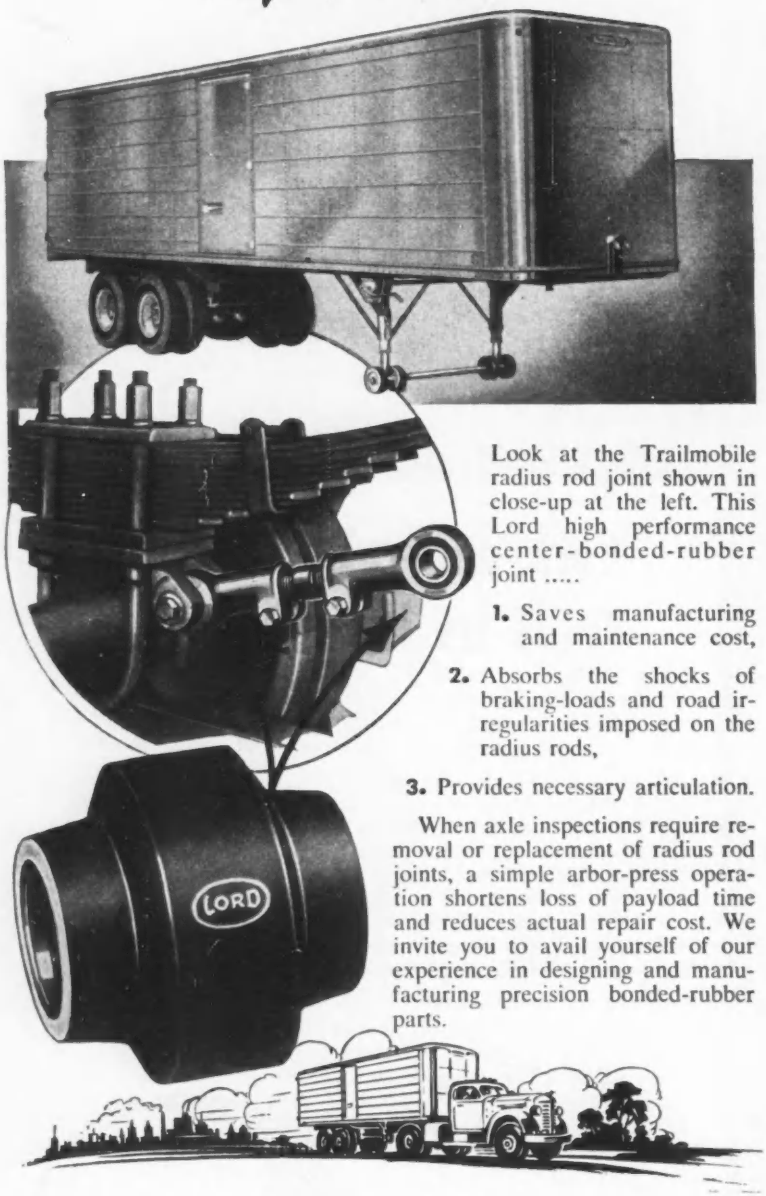
You can get Armstrong's DK-153 Tape in many widths and thicknesses, and in rolls, sheets, and die-cut shapes. For samples, write on letterhead to Armstrong Cork Company, Gaskets and Packings Department, 6802 Arch St., Lancaster, Penna. Available for export.



ARMSTRONG'S DK-153 TAPE

TRAILMOBILE

RADIUS ROD JOINTS *by* LORD



Look at the Trailmobile radius rod joint shown in close-up at the left. This Lord high performance center-bonded-rubber joint .....

1. Saves manufacturing and maintenance cost,
2. Absorbs the shocks of braking-loads and road irregularities imposed on the radius rods,
3. Provides necessary articulation.

When axle inspections require removal or replacement of radius rod joints, a simple arbor-press operation shortens loss of payload time and reduces actual repair cost. We invite you to avail yourself of our experience in designing and manufacturing precision bonded-rubber parts.

BURBANK, CALIFORNIA 233 South Third Street
DALLAS, TEXAS 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 7310 Woodward Ave.
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
ERIE, PENNSYLVANIA 1635 West 12th Street

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for
VIBRATION CONTROL

INDEX TO ADVERTISERS

(Continued from page 459)

Gear Specialties, Inc. 382
General Electric Co., Apparatus Dept. 18-19-20-21, 38-39
General Industries Co. 291
Gerotor May Corp. 338
Geuder, Paeschke & Frey Co. Contract Div. 398
Gits Bros. Mfg. Co. 257
Glass Fibers Inc. 427
Glidden Co., The 229
Goodrich Co., B. F. (Rivnut) .. 37
Goodyear Tire & Rubber Company (Mech. Goods) 15
Grammes & Sons, Inc., L. F. ... 434
Grant Pulley and Hardware Co. 450
Gray Iron Founders' Society Inc. 435
Gray and Prior Machine Co. ... 392
Great Lakes Screw Corp. 44
Great Lakes Steel Div., National Steel Corp. 233
Gries Reproducer Corp. 420

H. & R. Industries 436
Hanna Engineering Works 413
Harper Company, H. M. 44
Hartford Steel Ball Co. 438
Hartwell Company 320
Haydon Mfg. Co., Inc. 455
Heim Co. 86
Heinze Electric Co. 434
Heil-Coil Corp. 293
Heyman Mfg. Co. 438
Hilliard Corp. 388
Hills-McCanna Co. 304
Hitchiner Mfg. Co., Inc. (Metal Products Sales Co.) 358
Houghton & Co., E. F. 355
Howard Industries, Inc. 381
Howell Electric Motors Co. 411
Hyatt Bearing Div., General Motors Co. 83

Imperial Pencil Tracing Cloth Co. 396
Improved Seamless Wire Co. ... 416
International Nickel Co., Inc. Nickel Alloy 99
Irvington Varnish & Insulator Co. 239

Johnson Bronze Co. 369

KSM Products Incorporated ... 303
Kaydon Engineering Corp. 231
Kohler Company 281
Kold-Hold Mfg. Co. 256
Kollsman Instrument Corp. 437
Koppers Co., Inc., Plastics Div. 313
Kraissl Co., Inc. 278
Kurz-Kasch, Inc. 6

Laminated Shim Company, Inc. Shim Division 247
Laminated Shim Company, Inc. Stamping Division 246
Lamson & Sessions Company. 44
Lefax 392
Leland, Inc., G. H. 266
Linde Air Products Company, Unit of Union Carbide & Carbon Corp. 449
Linear Incorporated 342
Link-Belt Company ...11, 13, 41, 50-51
Link Engineering Co. 372
Lion Fastener, Inc. 380
Lord Mfg. Company 460
Lovejoy Flexible Coupling Co. 342
Lycoming-Spencer Div. Avco Mfg. Co. 311

McDonnell and Miller Inc. 396
McGill Mfg. Co., Inc. 261
McGraw-Hill Book Co., Inc. 245, 328
M. B. Mfg. Co., Inc. 433
Mallory & Co., Inc., P. R. 4, 81
Manhattan Rubber Co. 106-107
Marsh Co., C. W. 305
Master Electric Co. (Speedmaster) .....3rd Cover

INDEX TO ADVERTISERS

Metals & Controls Corp., General Plate Div. 70
Metals & Controls Corp., Spencer Thermostat Div. ... 74
Meyercord Co., Name Plate Div. 422
Michigan Tool Co. Cone-Drive Gears Division 250-251
Micro Switch Div. Minneapolis-Honeywell Regulator 76-77
Midland Steel Products Co.... 446
Milford Rivet & Machine Co... 301
Miller Motor Co..... 325
Miniature Precision Bearings Inc. 56
Minneapolis-Honeywell Regulator Co. Industrial Div..... 443
Minnesota Mining & Mfg. Co... 84
Minnesota Rubber & Gasket Co. 391
Monsanto Chemical Co..... 103
Moraine Products Div. General Motors Corp. 335
Morse Chain Co..... 267
Morton Machine Works..... 396
Mt. Vernon Die Casting Corp. 66
Mueller Brass Co..... 275

National Bearing Div., America Brake Shoe Co..... 409
National Lock Co..... 44
National Lock Washer Co. (Retaining Rings) 419
National Malleable & Steel Casting Co. 294
National Motor Bearing Co., Inc. 54
National Screw & Mfg. Co..44, 408
National-Standard Co. 48
National Steel Corp..... 233
National Tube Co.....297-300
National Vulcanized Fibre Co. 393
Newark Wire Cloth Co..... 428
New Departure Div. General Motors Corp. 118
New Jersey Zinc Company... 12
New York Belting & Packing Co. (Gilmer Products) ...108-109
Ney Co., J. M..... 420
Nice Ball Bearing Company... 322
Nicholson & Company, W. H.. 276
Norma-Hoffman Bearings Corp. 431
Nugent & Co., Inc., Wm. W... 461

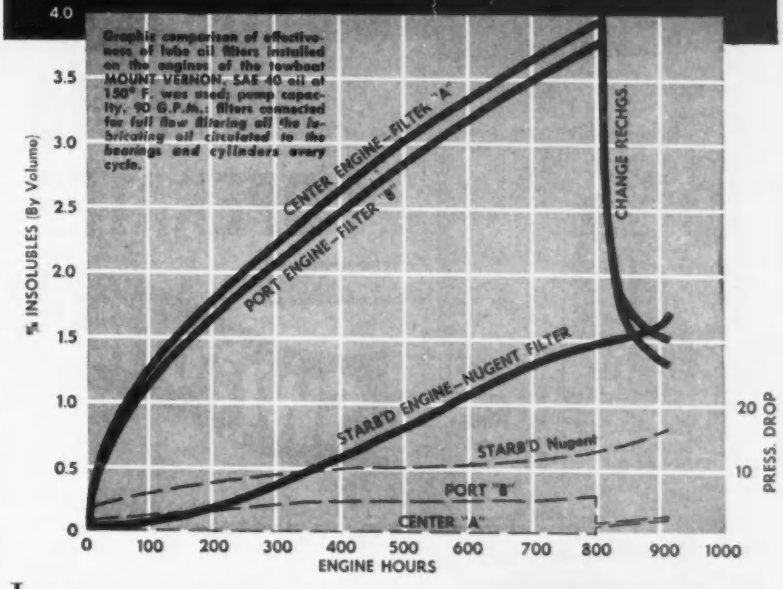
Ohio Knife Company..... 407
Ohmite Mfg. Co.....367-368
Oilgear Co. 349
Onan & Sons, Inc., D. W..... 292
Oregon Lumber Company.... 316
Ortman-Miller Machine Co.... 379

Packard Electric Div., Gen. Motors Corp. 405
Parker Appliance Co..... 359
Parker-Kalon Corporation ..28-29
44
Parker Rust Proof Company 46-47
Parker White-Metal Company 429
Pathon Mfg. Co..... 376
Penn Metal Co., Inc..... 282
Periflex, Incorporated 302
Perkins Machine & Gear Co... 426
Pheoll Mfg. Company..... 44
Philadelphia Gear Works Inc... 356
Pittsburgh Plate Glass Fiber Glass Div. 401
Pittsburgh Plate Glass Co., Brush Division 388
Pneu-Trol Devices, Inc. 316
Pope Machinery Corp..... 385
Precision Rubber Products Corp. 287
Product Engineering 110-111
Production Instrument Company 342
Progressive Mfg. Co..... 376
Projectile & Engineering Co. Ltd. 332

R. B. M. Division of Essex Wire Corp. 284
Ramsey Corporation 350

(Continued on page 462)

Side-by-side Comparison under operating conditions proves the superiority of NUGENT Filters


Graphic comparison of effectiveness of lube oil filters installed on the engines of the towboat MOUNT VERNON. SAE 40 oil at 150° F. was used; pump capacity, 90 G.P.M.; filters connected for full flow filtering all the lubricating oil circulated to the bearings and cylinders every cycle.
% INSOLUBLES (By Volume)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
CENTER ENGINE—FILTER "A"
PORT ENGINE—FILTER "B"
CHANGE RECHGS.
STARB'D ENGINE—NUGENT FILTER
STARB'D Nugent
PORT "B"
CENTER "A"
0 100 200 300 400 500 600 700 800 900 1000
ENGINE HOURS
20
10
PRESS. DROP

IN order to unquestionably determine the relative effectiveness of three leading lube oil filters, the owners of the towboat, MOUNT VERNON, installed a different make of filter on each of the boat's three identical engines. At regular intervals for 800 engine hours, the cleanliness of the oil was checked and recorded. The graph above shows the results—at the end of 800 hours the oil that was Nugent filtered contained less than half the concentration of insolubles as the more effective of the other two filters. Note, too, that oil passing through the other two filters was dirtier in 200 hours than the Nugent filtered oil was at the end of 800 hours.

Nugent filtering will give you this effectiveness, too. It will add to the life of your engines by reducing the amount of harmful impurities that reach vital working parts. It will extend the life of lube oil by keeping it cleaner longer.

For full information on how Nugent filtering can help you, write, outlining your filtering problem. Descriptive literature on Nugent filters is also available on request.

Nugent filter of the type used in the test aboard the MOUNT VERNON.

NUGENT TRADE MARK

Wm. W. Nugent & Co., Inc.

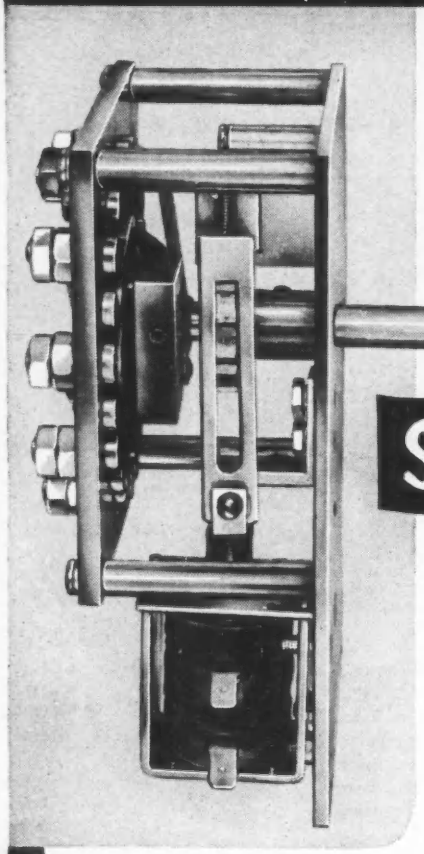
441 N. Hermitage Ave. CHICAGO 22, ILLINOIS

Established 1897

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles • Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco • Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

Ruggedly Designed for Dependable, Heavy-Duty Operation



TECH LABS SOLENOID OPERATED SWITCHES

When operating conditions demand a solenoid switch that will stand up under the most rugged requirements, always choose Tech Laboratories Solenoid Switches. These multi-pole units are built to "take it" and are designed and produced to meet your individual requirements.

According to your specifications you can get:

- Remote push-button operation, with or without manual reset.
- Single or dual direction operation.
- Single, or up to 8 decks.
- Single pole to 4 poles per deck.
- Two contacts up to several hundred contacts per deck.
- Shorting or non-shorting.
- Ceramic or phenolic insulation.
- Load capacities up to 10 Amp.—120 Volts AC (depending on number of contacts).
- Long, trouble-free service life.

Information on these and our additional line of motor operated switches is yours for the asking . . . Write today for complete catalog.

TECH LABORATORIES, INC.

Manufacturers of Precision Electrical Resistance Instruments

PALISADES PARK, NEW JERSEY

INDEX TO ADVERTISERS

(Continued from page 461)

Randall Graphite Bearings, Inc.
Raybestos-Manhattan, Inc. ..106-107
Equipment Sales Division
Manhattan Rubber Division
Packings Division
Reeves Pulley Company 252
Republic Steel Corp. Bolt & Nut Div. 243
Republic Steel Corp. Steel & Tubes Div. 235
Resistoflex Corp. 430
Reuland Electric Co. 254
Revere Copper & Brass, Inc. ..2, 35
Reynolds Metals Company ...92-93
Reynolds Wire Div. National Standard Co. 14
Rhode Island Tool Company ... 320
Rhodes, Inc., M. H. 378
Rigidized Metals Corp. 418
Rivett Lathe & Grinder Inc. ... 255
Robbins and Myers Inc. 30-30A
Rockford Clutch Div., Borg-Warner 350
Rockford Screw Products Company 44
Rockwood Sprinkler Co. (Ball Valve Div.) 421
Rogers Corp. 425
Roland Teiner Company 436
Roller Bearing Co. 378
Roll Formed Products Co. 410
Rollway Bearing Company, Inc. 318
Ross Operating Valve Company 1
Ruthman Machinery Co. 418

SKF Industries, Inc. 404
Sanborn Co. 384
Scaife Co. 372
Schatz Mfg. Company 22
Scintilla Magneto Div. Bendix Aviation Corp. Electrical Connectors 380
Scintilla Magneto Div. Bendix Aviation Corp. H & K Magneto Div. 348
Scovill Mfg. Company 44
Screw Research Association ... 44
Sealol Corp. 290
Sewall Mfg. Co., E. B. 276
Shafer Bearing Corp. 350
Shakeproof, Inc. 44, 75
Sharon Steel Corp. .....2nd Cover
Shaw Insulator Co. 390
Skinner Electric Valve Div., The Skinner Chuck Co. ... 332
Simmonds Aerocessories 354
Simmons Fastener Corp. 59
Smith Corp., A. O., Motor Div. 364
Southco Div., South Chester Corp. 310
Southern Friction Materials Co. 450
Southington Hardware Mfg. Co. 44
Spaulding Fibre Co., Inc. 361
Speer Carbon Co. 331
Split Ball Bearing Company .. 434
Sponge Rubber Products Co. ... 417
Square D Company 58
Staedtler, Inc., J. S. 288
Stalwart Rubber Company 259
Standard Pressed Steel Co. 64
Standard Tube Company 324
Stanley Chemical Company ... 314
Star-Kimble Motor Division Miehle Printing Press & Mfg. Co. 283
Steel Founders' Society of America 360
Stephens-Adamson Mfg. Co. ... 397
Sterling Bolt Co. 44
Sterling Electric Motors, Inc. ... 370
Sterling Engineering Co. 424
Stevens Mfg. Co., The 227
Stewart Warner Corp. Alemite 85
Stewart Warner Corp. Stewart Die Casting Div. 61
Streeter-Amet Co. 392
Strom Steel Ball Co. 302
Strong Carlisle and Hammond Co. 438
Stronghold Screw Products Inc. 44
Stupakoff Ceramic & Mfg. Co. 95
Superior Steel Corp. 263
Superior Tube Co. 414
Sweet's Catalog Service 72-73

INDEX TO ADVERTISERS

Tech Laboratories, Inc..... 462
Technical Survey 332
Telechron Dept. General Electric Co. 36, 57
Tennessee Coal, Iron & Railroad Co. 297-300
Thomas & Betts Co..... 403
Thomas Flexible Coupling Co. 288
Timken Roller Bearing Co. (Industrial) 97
Tinnerman Products, Inc..... 116
Titchener & Co., E. H..... 362
Tomkins-Johnson Company .. 354
Torrington Co., Bantam Bearings Division 91
Torrington Co. 253
Townsend Co. 352
Trabon Engineering Company 464
Transue & Williams Co., Stamping Div. 387
Tri-Clover Machine Co..... 415
Tuttle & Kift, Incorporated... 339
Twin City Die Castings Co.... 280
Twin Disc. Clutch Company.. 265

Union Carbide & Carbon Corp., Bakelite Co. 377
Linde Air Products Company 449
Unitcast Corporation 325
United-Carr Fastener Corp.... 400
U. S. Graphite Company..4th Cover
U. S. Rubber Company (Mechanical Goods) 80
U. S. Steel Co.....297-300
U. S. Steel Export Co.....297-300
U. S. Steel Supply Co.....297-300

V & O Press Co. Div of Emhart Mfg. Co..... 30B
Veeder-Root Incorporated 17
Vellumoid Co. 386
Vickers, Incorporated 60
Viking Pump Company..... 448

Waldes-Kohinoor, Inc. 55
Warner Electric Brake & Cluteh Co. 62-63
Washington Steel Corporation 112
Webster Electric Co..... 289
Weckesser Company 386
Welco Motors 444
Wellman Company, S. K..... 295
Wesche Electric Co., B. A.... 444
Western Felt Works..... 366
Westfield Metal Products Co. Inc. 442
Westinghouse Air Brake Company 42-43
Westinghouse Electric Corp..65-87
White Dental Mfg. Co., S. S.. 463
Winsmith Inc. 274
Wolverine Tube Div., Calumet & Hecla, Inc..... 16

Yoder Company 308

■

PROFESSIONAL SERVICES.... 454

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EMPLOYMENT
Positions Vacant.....451-454
Selling Opportunities Offered.... 451
Positions Wanted..... 451
Selling Opportunities Wanted.... 451

SPECIAL SERVICES 451
Contract Work..... 454

BUSINESS OPPORTUNITIES
Offered 451

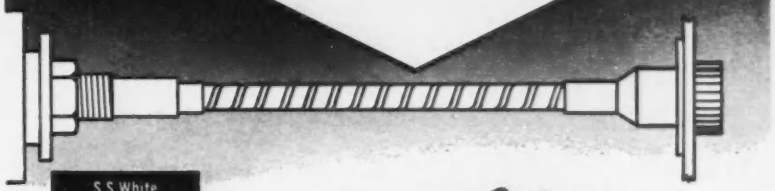
EQUIPMENT
(Used or Surplus New)
For Sale..... 454

■

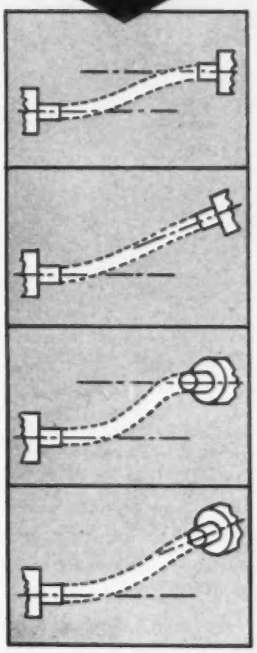
Advertisers' Index starts on 458

Product Index starts on... 455

Cost-cutting answer to your alignment problems



S.S.White Flexible Shafts are "naturals" for jobs like these



FLEXIBLE S.S.White SHAFTS

Alignment is never a factor when you use an S.S.White flexible shaft to transmit power or control between two points. The non-rigid construction of the shaft automatically compensates for any misalignment that may exist — and thereby eliminates the costly machining and assembly and many of the operational difficulties often experienced with rigid couplings.

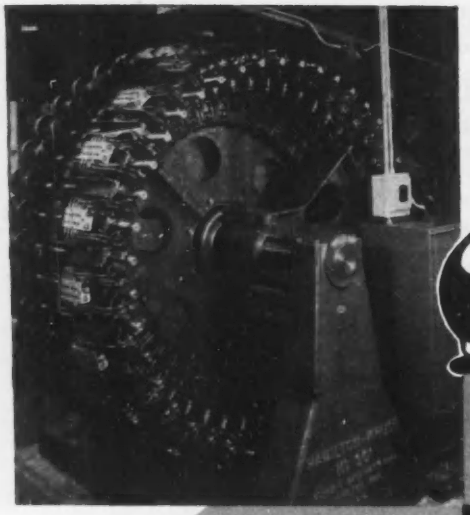
S.S.White engineers will be glad to make recommendations regarding the most suitable shaft for your specific problem. Call them in today. There is no cost or obligation.

WRITE FOR THE FLEXIBLE SHAFT HANDBOOK

256 pages of facts and data on how to select and apply flexible shafts. Copy sent free if you write for it on your business letterhead. No sales follow-up will be made unless requested.

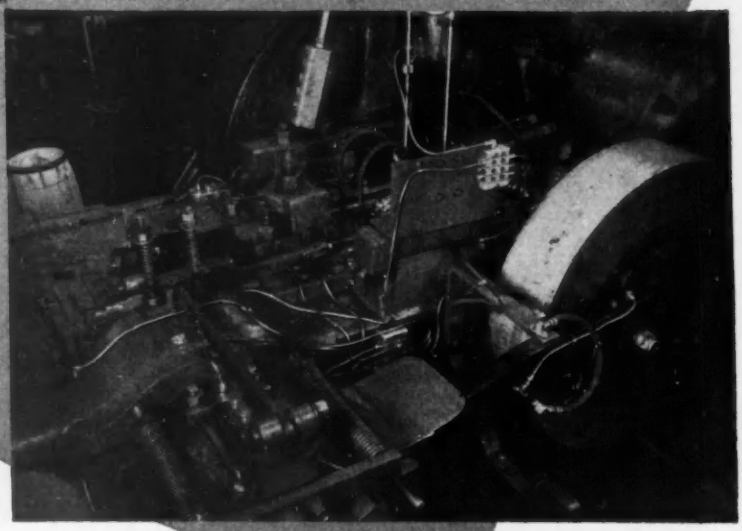
THE S.S.White DENTAL MFG. CO. INDUSTRIAL DIVISION
Dept. D, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California



ENGINEERED LUBRICATION WILL CUT Maintenance Costs 90%

this has a BEARING on the subject



Properly planned and engineered, lubrication can result in tremendous savings in your plant. Trabon Automatic Systems have been proving this in industry everywhere.

One example is shown above. The rivet heading machine illustrated, equipped with a Trabon Automatic System, has been in operation 3 years — and has never been down for bearing repairs. Lubrication is controlled by the start and stop of the machine, assuring the proper amount of oil to each point at all times.

In the second illustration, there are 221 lubrication points on this can machine. The Trabon system lubricates all bearings with a Trabon pump which rotates with the machine.

These two machines are merely typical of the thousands of Trabon Systems installed on equipment of all kinds over the past 22 years.

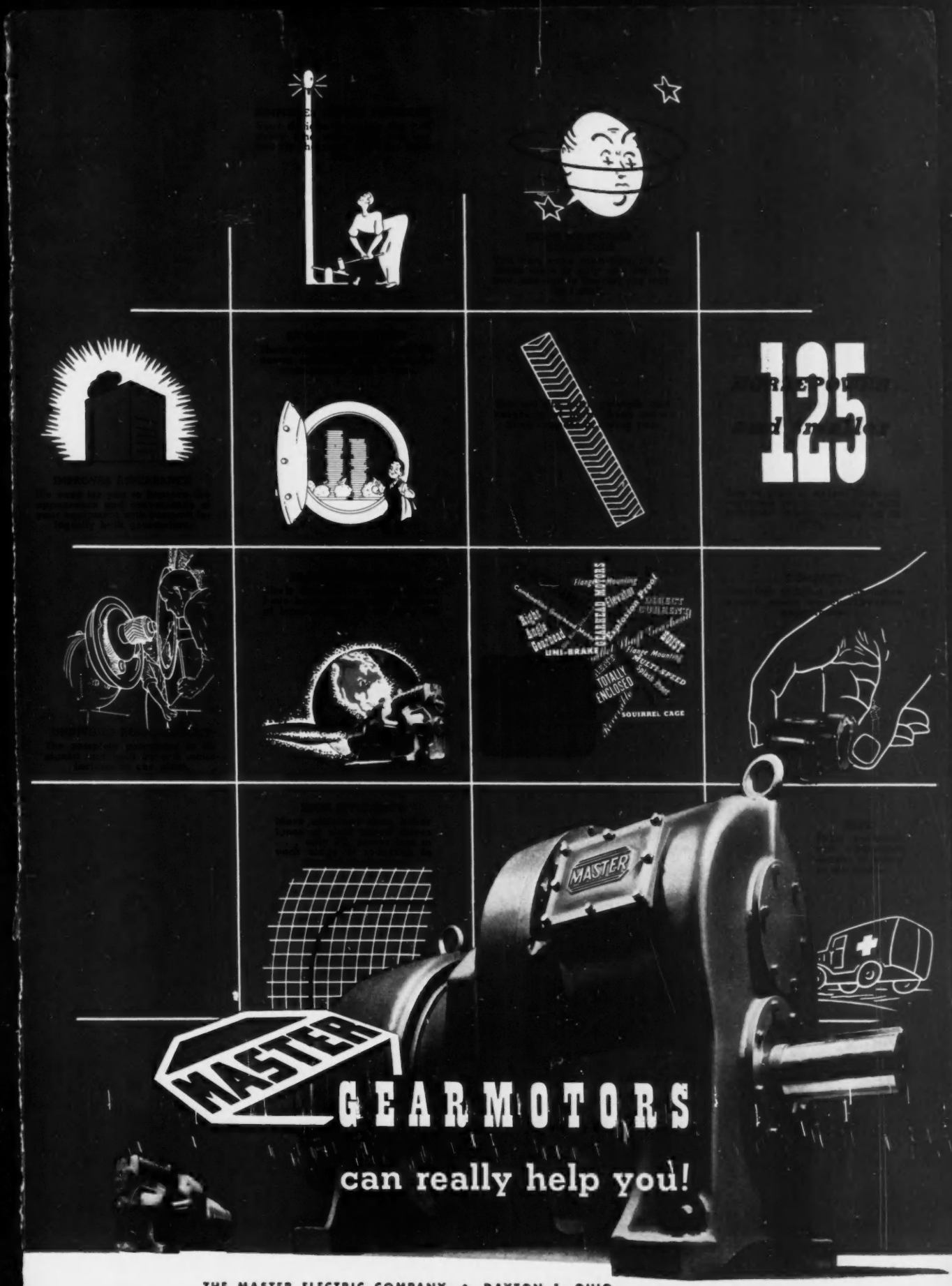
Trabon is a proven System, guaranteed to save money by reducing maintenance cost, and increasing your production.

A Trabon System is positive; hydraulic; handles oil or grease; is completely sealed; and has a single indicator at the pump which gives 100% proof that all bearings have been lubricated.

Ask us for Bulletin 529.

Trabon Automatic Lubrication Fits Any Bearing Situation.

Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems


125
MASTER
GEARMOTORS
can really help you!
THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

for lowest cost

precision bronze bearings in production quantities

USE GRAMIX®

These typical GRAMIX precision bronze bearings, with tolerances as close as .0005, are produced at a considerably lower cost than identical machined parts—in fact, in quantities of 10,000 or more, you can buy these bearings for your applications at the prices shown.

The average die cost for these bearings is about $300; but, since we have produced literally millions and millions of these bearings, we have dies available for more than 132,000 size and shape variations. This great number of die combinations available to you without cost to meet your specifications.

GRAMIX sintered-metal bearings cut production costs because they have precision tolerances consistently maintained by accurate production control. Maintenance costs are lower because the inherent porosity, filled with a lubricant, assures positive operation. For complete information on how GRAMIX can save you money, write us today.

94

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN